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Application of the Urban Airshed Model to the New York Metropolitan Area

by

S. Trivikrama Rao
Bureau of Air Research
Division of Air Resources
New York State Department
of Environmental Conservation
Albany NY 12233-3259

CA No. CX811945-01-0

EPA Project Officer: Johnnie L. Pearson

Prepared for

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ABSTRACT

Ambient ozone concentrations in the New York Metropolitan area, encompassing portions of the States of New Jersey, New York and Connecticut, often exceeded the ozone National Ambient Air Quality Standard (NAAQS) of 0.12 ppm during the 1980 ozone season. To address this problem, a study entitled "Oxidant Modeling for the New York Metropolitan Area Project (OMNYMAP)" has been undertaken. The goals of this modeling study are to provide information on (a) the extent and magnitude of the ozone problem in the New York Metropolitan area during the 1988 ozone season; (b) the impact/benefit achieved with imposition of specific control strategies to which the three states committed themselves in their State Implementation Plans (SIPs); (c) the role of pollutant transport from the upwind regions into the modeling domain; and (d) meaningful and effective control strategies to meet and maintain ozone NAAQS in the New York Metropolitan area.

In this study, the urban AIRSHED model (UAM) has been used to simulate five high ozone days in the 1980 oxidant season. Typical characteristics of the five high ozone days were as follows: wind flow generally from the south to southwest at about 4 to 5 m/s, daily maximum surface temperature in the range of 30 to 35°C (86 to 95°F) and measured ozone concentrations exceeding 200 ppb within Connecticut. The emissions input data base consisted of major and minor point sources, area sources, and mobile sources. The inventory was compiled for the region on an hourly basis for NO_x, CO, and VOC emissions in terms of speciated components characterized by the Carbon Bond II (CBII) chemical mechanism.

The model results have been analyzed to assess the performance of the model in simulating the observed ozone concentrations. Various statistical measures were applied to the data for each of the five simulated days as well as for the ensemble data. A comparison of the observed and corresponding predicted concentrations as a pair indicates that the model performed reasonably well with correlation coefficients in the range of 0.47 to 0.75 for the five days. Examination of the model performance with the data base comprised of ozone concentrations greater than 100 ppb reveals that 60% of the predicted values were within ±30% of their corresponding observed concentrations with the remaining values distributed evenly between the under- and over-prediction

categories. However, the model has a tendency to underpredict the peak or the maximum concentrations over the modeling domain. These results are consistent with evaluations of the UAM performance at other urban areas by the U.S. Environmental Protection Agency.

The UAM was then applied to assess the impact of emissions controls implemented under the State Implementation Plans (SIPs) of the three states for 1988 together with appropriate reductions in the pollutant concentrations at the upwind boundary for two of the five days during which UAM performed the best. The modeling results indicate that although there is a decrease in the 1988 peak ozone levels, the predicted maximum concentrations are well above the NAAQS for ozone. Even with the imposition of all the extraordinary emissions control measures committed to under the SIPs, the results of a one day simulation reveal that the peak ozone level continues to be well above the NAAQS.

Analysis of the sensitivity of the model output to specific model input conditions discloses that pollutant transport into the modeling region is extremely important. Hence, serious consideration should be given to this feature in addition to other emissions reduction plans for developing meaningful and effective strategies to meet and maintain the ozone NAAQS in the New York Metropolitan area. Additional modeling analyses are necessary to quantify the level of reduction in the precursor emissions required to meet the ozone NAAQS in this area.

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INTRODUCTION

Pursuant to the 1970 Clean Air Act Amendments (CAA), the U.S. Environmental Protection Agency (USEPA) has promulgated the primary and secondary National Ambient Air Quality Standard (NAAQS) for ozone. As stated in the 36 Federal Register 8186 (April 1971), this standard was "0.08 ppm maximum one-hour concentration not to be exceeded more than once per year" as measured by the reference test method for ozone. However, the measured concentrations often exceeded this value in both urban and rural locations. Subsequently, based upon information on the health effects of ozone in the atmosphere, the USEPA revised the NAAQS to 0.12 ppm in 1979 with the standard being attained when "the expected number of days per calendar year with maximum hourly average concentration above 0.12 parts per million is equal to or less than 1" (40 CFR 50.9). Under Section 110 of CAA, state and local air pollution control agencies are required to specify the methods that are to be implemented to reduce precursor emissions in urban areas to the extent necessary to comply with the NAAQS. These measures are to be identified in their State Implementation Plans (SIPs). To accomplish this in an equitable manner, the regulatory agencies must be able to relate the existing emission patterns from specific urban source areas to air quality at downwind receptor locations, expressed in terms of ground-level ozone concentrations.

Ozone is not usually emitted directly into the atmosphere, but is instead a secondary pollutant that is formed over a period of time from a variety of atmospheric reactants. The USEPA has specified a number of modeling techniques for estimating the required percentage reduction of precursor (hydrocarbon and oxides of nitrogen) emissions from an urban source area necessary to meet the air quality standards. Since implementation of an emission control strategy may require tremendous economic commitments and may cause severe social dislocation, reliable estimates of ozone concentrations due to the impact of precursor emissions from the specific urban area in question must be available prior to making a decision to adopt a particular control strategy for the area.

Downwind ozone levels are related to a specific area's precursor emissions, and transported ozone and precursor concentrations, by the mathematical models which predict these relationships in such a manner that various control strategies can be evaluated. Confidence can be placed in the impact evaluation process only if reliable ozone prediction relationships are employed. Approaches for determining the level of emission reductions necessary to attain the NAAOS include, in the order of increasing complexity, linear rollback, the "Appendix J" method, empirical kinetics model, and numerical models for photochemical oxidants. The choice of approach not only affects the scientific credibility of results, but also the ease of implementation in areas having limited or none of the required input data, and/or the expertise required to utilize the approach.

Rollback models, which are now unacceptable, assume a direct proportionality between air quality and emissions. Thus, a reduction of a secondary pollutant concentration such as ozone, is assumed to be directly proportional to a reduction in source emissions for an entire region. This method may be used for regions only where very little detailed data are available, and then, too, only for screening purposes. Hence, this highly simplified approach to ozone modeling is largely outmoded.

The "Appendix J," or upper limit oxidant - hydrocarbon concentration approach, is a technique developed in the early 1970's which attempted to develop a simple relationship between afternoon oxidant levels and morning hydrocarbon concentrations. Since the model completely disregards the site-specific or local effects of nitrogen oxides, meteorology, and ozone transport, this approach also is no longer considered valid by USEPA.

Empirical kinetics models represent an attempt to develop the relationships between ambient ozone concentrations and precursor emissions, based on smog chamber simulations. Initial concentrations of various precursor mixtures are introduced into the smog chamber and are subjected to sunlight to induce photochemical activity. Resulting ozone concentrations are observed as a function of time. The ozone concentrations for various simulations are plotted in an isopleth form as functions of initial concentrations of non-methane hydrocarbons (NMHC) and oxides of nitrogen (NO_x). This information was utilized to develop the USEPA Model, Empirical Kinetics Modeling Approach known as EKMA. The EKMA model is probably the most reasonable model currently available for relatively widespread use. There are, however, some limitations to the model. For example, ambient precursor concentrations within the urban area are assumed to be directly proportional to emissions. Differences may exist between NMHC/NO_x ratios from measured concentrations and those deduced from emissions inventory data. Another problem is related to the treatment of background concentrations. Because of very rapid reactions between NO and O_3, the pre-existing ozone in an air mass moving into an urban locale is not necessarily additive to the ozone buildup resulting from locally emitted precursor pollutants. In addition, EKMA cannot predict spatial effects, does not allow horizontal pollutant exchange with air outside the parcel, and assumes instantaneous complete mixing in the vertical direction as the height of the air column (mixing height) increases. Furthermore, EKMA is unable to predict ozone concentrations at locations not represented by physical monitors. Finally, for a large urban area such as New York the trajectory approach is inadequate to describe the physical mechanisms of the large plume and the effects of a variety of meteorological conditions.

Numerical photochemical transport and dispersion models such as the Urban Airshed Model, UAM (Reynolds, 1979), and Livermore Regional Air Quality Model, LIRAQ (McCraken, et al., 1975) and the Cal Tech photochmeical grid model (McRae, et al., 1982) are among the most sophisticated of the approaches, and are well-suited for predicting the spatial and temporal distributions of ozone concentrations downwind of urban areas. In theory, numerical modeling approach is the best choice. However, in practice, numerous problems arise. These include the following: the difficulty of numerically solving the complex conservation of mass equations accurately; the high computational costs and expertise required for model implementation and interpretation; the unknown effects of treatments of the transport, diffusion, and reaction processes in the model due to limitations of available data and knowledge; the large data requirements for testing critical features of the model and its validation; and perhaps most importantly, the need for a spatially and temporally accurate emissions inventory.

Thus, it is evident from the above discussion that advanced models are required to properly identify the relationship between emissions and ozone concentrations. Equitable and effective control strategies can only be developed based on the numerical models since the photochemistry, transport, and diffusion of ozone are treated in detail by these state-of-the-science models. However, it is imperative that the emissions data base as well as the aerometric data used in the model are accurate to ensure that the modeling results are useful and credible. Further, the uncertainties associated with the model results must also be taken into account in the development of meaningful control strategies for ozone.

The goals of this project are to assess and quantify the ozone problem in the New York Metropolitan area, to evaluate the available control options and to develop effective and equitable strategies for reducing the ozone levels in the region through the application of the UAM photochemical oxidant model. The New York Metropolitan area includes portions of the states of New Jersey, New York, and Connecticut. As a part of this study, meteorological and ambient air quality data were analyzed to characterize those conditions that are conducive to the formation and production of peak ozone levels in the region. Based on this analysis, five typical high ozone days in the 1980 oxidant season were selected for detailed modeling analysis. The pertinent emissions and meteorological data were assembled to execute the UAM for these selected days for the base year, 1980. The model predictions were compared with the measurements to assess the model performance. These results indicate that the UAM performance in this study is similar to its performance in other urban areas such as Tulsa, St. Louis and Philadelphia.

Evaluation of the control options included emissions projections of the 1980 baseline to future scenarios (such as the 1982 SIP for 1988) in order to determine whether these measures will reduce the ozone concentrations to the level of the NAAQS in the region. These projections included changes in emissions arising from changes in population and activity levels, as well as specific changes in emissions associated with regulatory actions that are already mandated under the current laws and regulations and projected pollution reduction levels associated with upwind emissions control plans. Using the meteorological features observed in 1980, model simulations were performed to assess the impact of selected emissions reduction scenarios for two of the five days. Although the predicted peak concentrations in 1988 in the New York Metropolitan area are reduced from the base year levels, the predicted peaks are still well above the ozone NAAQS. Simulation of the UAM for one day with the imposition of all extraordinary emissions control measures included in the SIPs reveals that the peak ozone concentrations are still well above the ozone NAAQS. Finally, the sensitivity of the model to various input parameters was evaluated and the results suggest that transport of ozone and its precursors into the modeling domain significantly affects the ozone concentration field over the tri-state region. Additional modeling analyses are necessary to document clearly the dynamics associated with the oxidants and the level of reduction in the precursor emissions required to meet and maintain ozone NAAQS in the New York Metropolitan area.

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CHAPTER 2

CHARACTERISTICS OF A HIGH OZONE DAY

Studies of ambient ozone concentrations in the Northeastern part of the United States have reported that the NAAQS value of 0.12 ppm is often exceeded, with concentrations reaching as high as 300 ppb downwind of large urban regions. These exceedances are found region-wide, indicating that ozone is a pervasive air contaminant mainly occurring during the summer months of June, July and August, the so called "ozone season". In order to understand prevailing meteorological characteristics during the days of high ozone concentration, ambient air quality measurements from the states of New Jersey, New York, and Connecticut were examined for a six year period from 1978 to 1983. The criterion adopted to select a day as a high ozone day was that the maximum hourly concentration at a monitoring station be equal to or greater than 200 ppb. The days thus selected are listed in Table 2.1. The number of days range from a minimum of 5 days in 1982 to a maximum of 16 days in 1983 with a majority of them occurring over Connecticut. It should be noted that the number of monitoring stations and their locations often varied from year to year, and therefore a subset of high ozone days from Table 2.1 was selected such that there be at least two stations in Connecticut and at least one station in the New York-New Jersey area exceeding the 200 ppb concentration value. A general description of the meteorological features that are representative of this class of days is given below.

2.1 Synoptic-Scale Features

The daily weather maps published by the National Weather Service (NWS) were examined for the high ozone days both at the surface and upper levels. A fairly consistent weather pattern was observed along with a few outlying cases. Figure 2.1 shows a typical surface weather pattern for a high ozone day. A frontal zone stretched from the Northeastern U.S.-Canadian border westward and then southwestward through the eastern Great Lakes. High pressure prevailed over the Atlantic and westward through the southern States. The frontal position varied, in other cases, around this "average" position--latitudes from near James Bay to central New York and longitudes from western New York to the central Great Lakes. The "Bermuda High" varied in position from the Atlantic to the extreme

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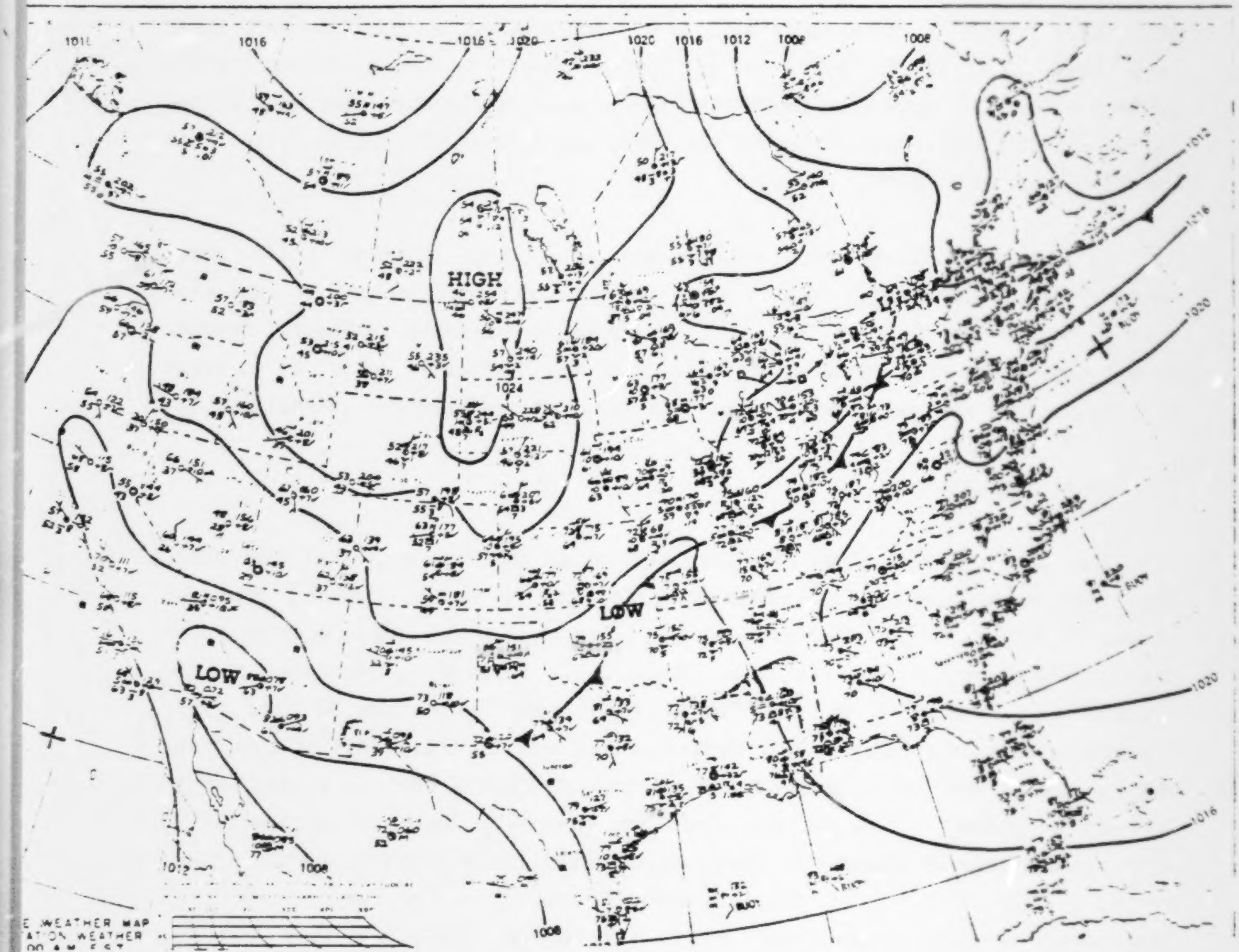
TABLE 2.1

Days Classified as "High Ozone Days" During the 1978-83 Oxidant Seasons, With Hourly Ozone Concentrations Greater Than or Equal to 200 ppb

Year	High Ozone Days (Jullian Day)*
1978	78166. 78170, 78171. 78178. 78202. 78226. 78227
1979	79167, 79194, 79201, 79205. 79206, 79213
1980	80167. 80176, 80177. 80193. 80198. 80202. 80203. 80204. 80219. 80221. 80240, 80241
1981	81166, 81167,81172, 81189, 81194. 81200
1982	82189, 82197, 82198, 82199, 82220
1983	83165, 83166, 83167, 83174, 83177, 83178, 83184. 83186, 83192, 83195. 83209, 83211, 83220, 83229, 83232, 83239.

*For example, Jullian Day 78166 corresponds to June 16, 1978.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1008
1008
HIGH
1024
LOW
LOW
1012
1016
1020
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1012
1008
1008
E WEATHER MAP
ATION WEATHER
00 A.M. E.S.T.

Figure 2.1 Typical Synoptic Scale Surface Weather Pattern for a High Ozone Day

southern Midwest. In addition, another characteristic feature that was observed on the smaller scale to the east of the Appalachian Mountains was a "lee-side trough", which extended with some variation, from southern New England southwestward to Virginia, the southern location being more pronounced and occurring more frequently (Pagnotti, 1987).

Near the region, cyclonic flow was found aloft in almost all cases with a short-wave trough approaching or passing through the region. Predominant upper level winds (500-700 MB level) varied from northwest through southwest, while surface winds were generally southwesterly. Precipitation over some part of the region was often observed while maximum temperatures over the region varied from the 80's to around 100°F.

In some instances, high ozone days were also observed under other meteorological conditions, usually with a surface cyclonic feature of some kind near or within the region. The latter included, for example, a frontal trough, or a low pressure area centered offshore or to the northeast. Also, a few cases had the surface and upper level winds from north or northeasterly directions.

2.2 Local Features

The local climatological data were scanned to describe a typical high ozone day. The meteorological variables averaged over 28 cases resulting from the subset classification for selected National Weather Service (NWS) stations over the tri-state region are listed in Table 2.2. Maximum temperatures in the region range from 85°F to 93°F, while the minima range from 66°F to 70°F. Precipitation occurs between 17% (Central Park) and 45% (Hartford) of the time, with a station mean of a hundredth of an inch at Central Park to a tenth of an inch at Bridgeport. The surface winds are generally south to southwesterly, with average hourly speeds for these days ranging from 3 m/sec (Hartford and, Atlantic City) to 5 m/sec (LaGuardia and Bridgeport). The average sky cover (sunrise to sunset) ranges from five to six tenths. Smoke and haze were the most common weather types reported, along with fog and occasional thunderstorms.

TABLE 2.2

Averages of Meteorological Variables for the High Ozone Days at Selected National Weather Service Stations in the Tri-State Region

STATION	TEMPERATURE (F°) MAXIMUM	TEMPERATURE (F°) MINIMUM	SURFACE WINDS SPEED (M/S)	SURFACE WINDS DIRECTION (°)	SKY COVER (TENTHS)	PRECIPITATION (INCHES)	FREQUENCY OF PRECIPITATION (PERCENT)
ATLANTIC CITY, NJ	89 ± 6	66 ± 7	3 ± 1	211 ± 34	5 ± 2	0.06	25
NEWARK, NJ	93 ± 5	72 ± 6	5 ± 1	219 ± 50	5 ± 2	0.04	28
La GUARDIA AIRPORT, NY	91 ± 5	72 ± 5	5 ± 1	192 ± 80	4 ± 2	0.02	24
JFK INTL. AIRPORT, NY	87 ± 6	70 ± 5	5 ± 1	206 ± 30	5 ± 2	0.02	24
CENTRAL PARK NYC, NY	92 ± 5	72 ± 6	4 ± 1	193 ± 70	--	0.01	17
BRIDGEPORT, CT	85 ± 6	67 ± 6	5 ± 1	220 ± 40	5 ± 2	0.10	41
HARTFORD, CT	91 ± 5	67 ± 6	3 ± 1	219 ± 54	6 ± 3	0.06	45

2.3 Selection of Modeling Days

By virtue of its design, the UAM requires the detailed input of various aerometric data sets for simulating the concentration field (Ames, et al., 1985a, 1985b). In a majority of the applications, the required input data are not available from routine measurements and have to be developed from special monitoring networks. One such network is the 1980 Northeast Corridor Regional Modeling Project (NECRMP, 1982a) conducted by USEPA, which provided a detailed and extensive aerometric data base for this region. An examination of the NECRMP data base for aircraft measurements (NECRMP, 1982b) and Table 2.1 reveals that of the 12 days only 5 days could be considered for the application of the UAM. The five days are JD80198(071680), JD80203(072180), JD80204(072280), JD80219(080680), and JD80221(080880).

A brief description of the synoptic weather pattern for these five days is given in Table 2.3. These days appear to fit the characteristic pattern discussed earlier for the high ozone day with a frontal array across the northeastern U.S. border, slightly disturbed west-southwesterly to west-northwesterly flow aloft, a weak surface trough east of the Appalachians, and a surface high pressure ridged from the Atlantic Ocean westward across the southern U.S. In Table 2.4 are listed the local climatological data for the five days. Most stations exhibit the typical conditions, namely, temperature maxima in the upper 80's and 90's °F, minima in the upper 60's and 70's °F, a prevalence of smoke, haze, some fog and occasional occurrence of thunderstorms. Average sky cover (sunrise to sunset) is generally five tenths or greater, and surface winds are generally south to southwesterly with wind speeds in the range 2-7 m/s.

TABLE 2.3

Synoptic Weather Pattern Summary for the Five Modeling Days Selected in 1980

JD80198 (071680)	Cold front lies from a position over Northern Indiana to Northern Maine; high pressure from the Atlantic westward to Texas; weak trough east of the Appalachian Mountains; small upper-level trough over the Northeast, with northwesterly flow aloft, and short wave approaching from the west.
JD80203 (072180)	Frontal array (cold front-stationary front) midwest through northern Maine; high pressure ridge from Atlantic westward to Alabama; trough east of the Appalachians; upper-level short-wave approaching from the west, with westsouthwesterly flow aloft.
JD80204 (072280)	Similar to JD80203(072180), except, southwesterly flow aloft.
JD80219 (080680)	Cold front approaching from southern Canada-Great Lakes region; high pressure from Atlantic westward to the southern Midwest; trough east of the Appalachians; upper-level disturbance to the northwest, with westerly flow aloft.
JD80221 (080880)	Stationary front - cold front Great Lakes to Northern New England; high pressure from Atlantic westward to the southern Midwest and Texas; slightly cyclonic flow east of the Appalachians; upper-level short wave approaching from the northwest, with west to northwesterly flow aloft and a weak disturbance over New England.

TABLE 2.4

Summary of Local Meteorological Observations for the Five Days Selected in 1980

Date	Temperature (°F)		Weather	Precipitation**	Average Wind		Sky Cover	
	Maximum	Minimum	Type*	(inches)	Direction	Speed (m/s)	(tenths)	Station
JD80198(071680)	93	68	3,8	T	200	4.4	7	Atlanti
JD80203(072180)	94	70	3,8	T	240	4.2	5	City
JD80204(072280)	90	67	3,8	1.26	240	4.4	7	NJ
JD80219(080680)	88	69	1,3.8	0.15	240	2.9	7	
JD80221(080880)	91	65	1,8	0	220	4.2	3	
JD80198(071680)	96	73	1,3,8	0.09	250	6.0	8	
JD80203(072180)	101	81	8	0	230	4.3	7	
JD80204(072280)	95	70	3	0.43	240	5.1	7	Newark
JD80219(080680)	90	73	8	0	250	4.4	6	NJ
JD80221(080880)	95	76	8	0	230	5.3	7	
JD80198(071680)	97	77	3,8	0.02	230	5.8	7	
JD80203(072180)	99	83	8	0	240	6.6	4	LaGuardi
JD80204(072280)	92	73	3,8	0.38	200	5.8	7	Airport
JD80219(080680)	90	76	8	0	270	5.0	5	NY
JD80221(080880)	94	79	8	0	220	5.8	6	
JD80198(071680)	84	70	1,3,8	0.05	210	5.0	7	JFK
JD80203(072180)	97	78	8	0	210	5.2	6	Airport
JD80204(072280)	87	72	3	0.19	210	6.0	6	NY
JD80219(080680)	89	75	8	0	230	4.6	6	
JD80221(080880)	93	76	8	0	240	5.6	7	
JD80198(071680)	99	77		0.03	220	4.4		Central
JD80203(072180)	102	82		0	230	4.1		Park
JD80204(072280)	94	72		0.28	240	3.7		NYC
JD80219(080680)	90	76		0	250	5.0		NY
JD80221(080880)	96	80		0	230	5.8		
JD80198(071680)	91	72		T	230	6.7	6	Bridge-
JD80203(072180)	97	75	3,8	0.22	230	5.6	6	port
JD80204(072280)	89	72	1,3,8	0.92	230	5.5	5	CT
JD80219(080680)	88	75	1,8	T	230	5.0	6	
JD80221(080880)	89	75	8	0	240	5.1	7	
JD80198(071680)	96	70	1,3,8	0.01	200	3.5	6	Hartfor
JD80203(072180)	90	71	1,3,8	0.16	280	2.5	9	CT
JD80204(072280)	91	69	1,3,8	0.35	250	5.1	8	
JD80219(080680)	89	71	1,3,8	0.08	250	2.2	7	
JD80221(080880)	92	70	8	0	230	2.6	6	

*Weather types: 1: Fog 3: Thunderstorm 8: Smoke, haze

**Total during the day and T corresponds to a trace of precipitation

CHAPTER 3

MODEL PREPARATION

The areal extent of the modeling region selected in this study was guided by the primary objective of capturing the peak ozone concentrations resulting from the emissions in New Jersey, New York, and Connecticut. Thus, the modeling domain includes almost all of the State of Connecticut and the high emission density regions of New York and New Jersey. Trenton, NJ was selected as the approximate location of the southwest corner of the modeling domain. The areal extent of the modeling region as shown in Figure 3.1, is 49.6 x 10^3 km^2 with east-west and north-south dimensions of 248 and 200 km, respectively.

3.1 Grid Cell Size

The UAM program utilizes the modeling region as a volume subdivided into an array of three-dimensional grid cells. The horizontal, i.e., the east-west, north-south plane is divided into cells of equal size. The vertical cell size is dependent upon the fixed number of layers into which the layer between the ground and the top of the simulation region is subdivided. In this study, an 8 km cell equal in east-west and north-south directions, was selected. This yielded 31 cells in the east-west direction and 25 cells in the north-south direction. The 8 km cell spacing was selected as a compromise between a 5 and a 10 km spacing, since the former would result in extensive data requirements and high computational costs, while the latter could be too coarse a cell size to provide the needed detail in the concentration field. The number of layers in the vertical direction was set to four, with three in the layer between the ground and the mixing height and one in between the mixing height and the top of the modeling region. The thickness of each of the four layers is dependent upon the hourly mixing height. A minimum height of 50 m was specified for the three layers below the mixing height, and 500 m for the layer in between the mixing height and the region top.

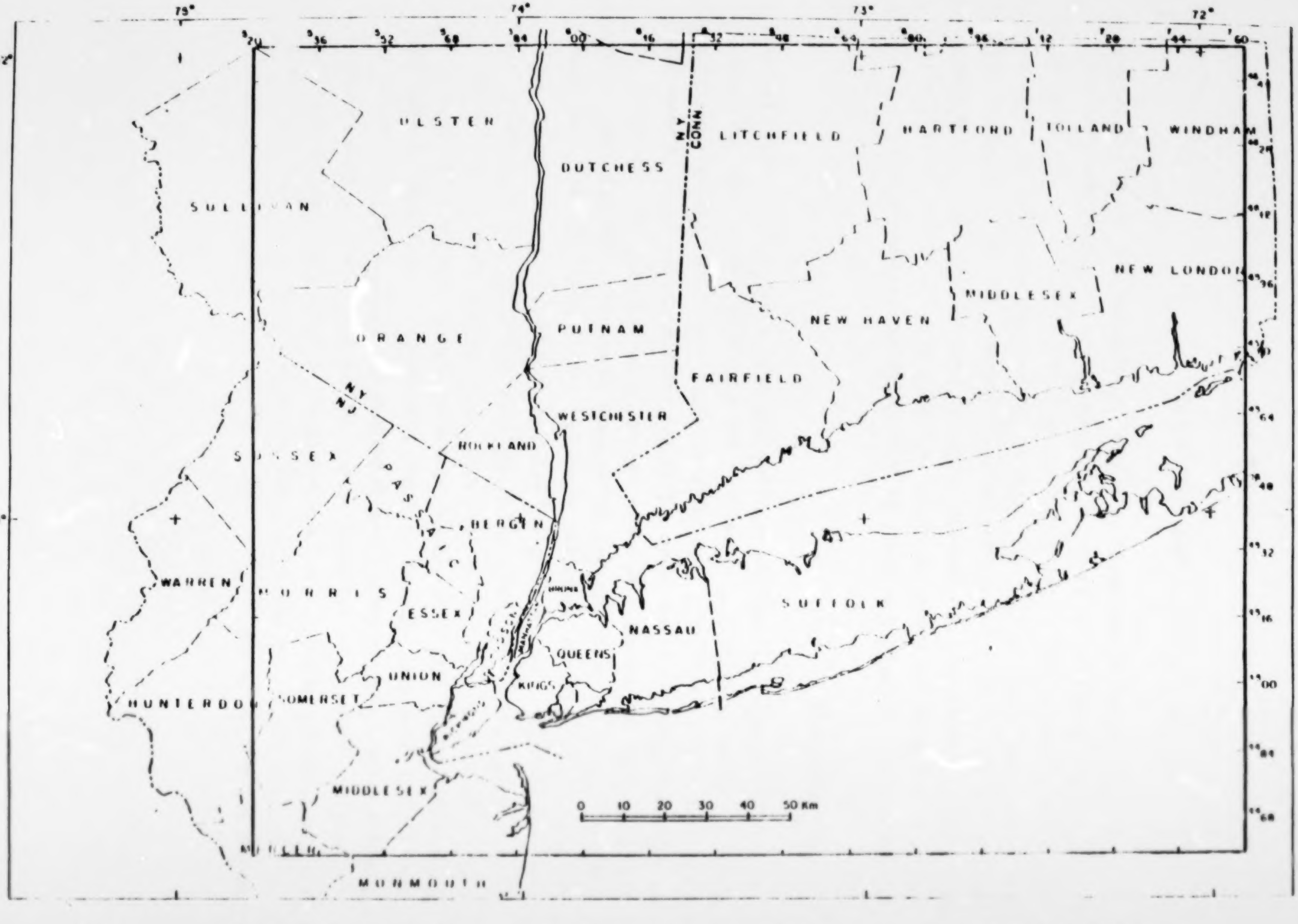

75°
74°
73°
72°
42°
41°
ULSTER
SULLIVAN
DUTCHESS
NY
CONN
LITCHFIELD
HARTFORD
TOLLAND
WINDHAM
NEW LONDON
MIDDLESEX
NEW HAVEN
ORANGE
PUTNAM
FAIRFIELD
NY
NJ
WESTCHESTER
ROCKLAND
SUSSEX
PASSAIC
BERGEN
WARREN
MORRIS
ESSEX
NASSAU
SUFFOLK
QUEENS
KINGS
UNION
SOMERSET
HUNTERDON
MIDDLESEX
MONMOUTH
0 10 20 30 40 50 Km

Figure 3.1 Areal Extent of the Modeling Region which Includes Portions of the States of New Jersey, New York, and Connecticut

Thus, in summary, the modeling region consists of:

31 cells in the east-west (X) direction,
25 cells in the north-south (Y) direction. and
4 cells in the vertical (Z) direction

with the southwest corner, the origin, set at UTM 520,000.0 m E, 446,000.0 m N and a cell size of 8,000 m. The UTM zone 18, was extended for the easternmost parts of Long Island and portions of eastern Connecticut.

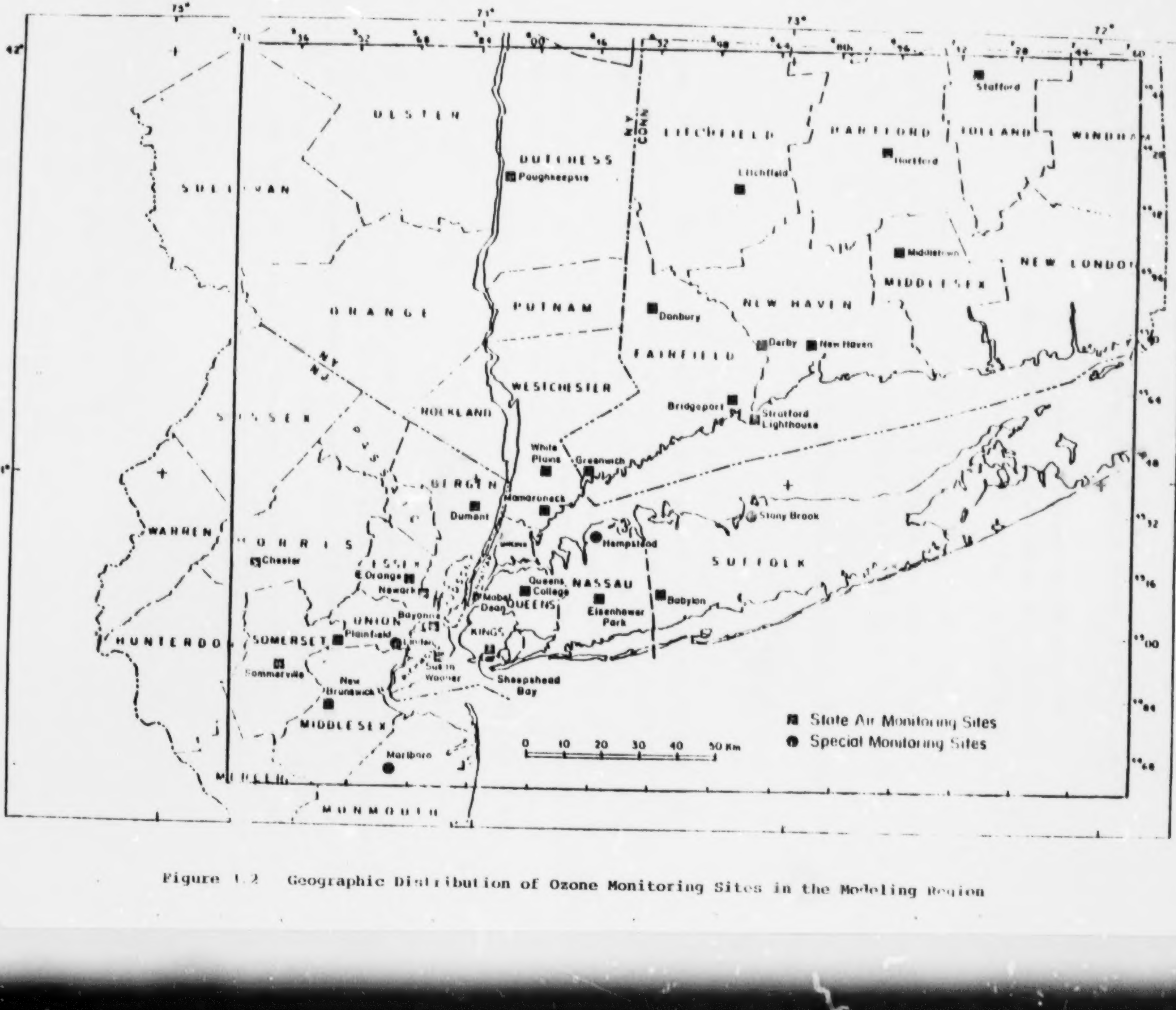
3.2 Ambient Air Quality and Meteorological Data

3.2.1 Ozone (O_3)

The geographic distribution of the ozone monitoring stations is shown in Figure 3.2. In general, monitoring data over the northwest quadrant are sparse, with the majority of the stations oriented along a southwest-northeast line. In addition to the routine monitoring stations, data are available at four other sites from NECRMP. These locations are also shown in Figure 3.2. On a state-by-state basis, the number of stations in Connecticut, New York and New Jersey were 10, 13 and 10, respectively with the majority of the New York and New Jersey stations located in the southwest quadrant of the model domain.

3.2.2 Non-Methane Hydrocarbons (NMHC)

The locations of the non-methane hydrocarbon monitoring stations are shown in Figure 3.3. It should be noted that no routine monitoring was performed for these pollutants and that the sites shown in Figure 3.3 represent the special sampling locations set up under the NECRMP. The stations were principally located in the southwest quadrant and were the only ones available for developing the initial NMHC distribution over the modeling domain.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DUTCHESS
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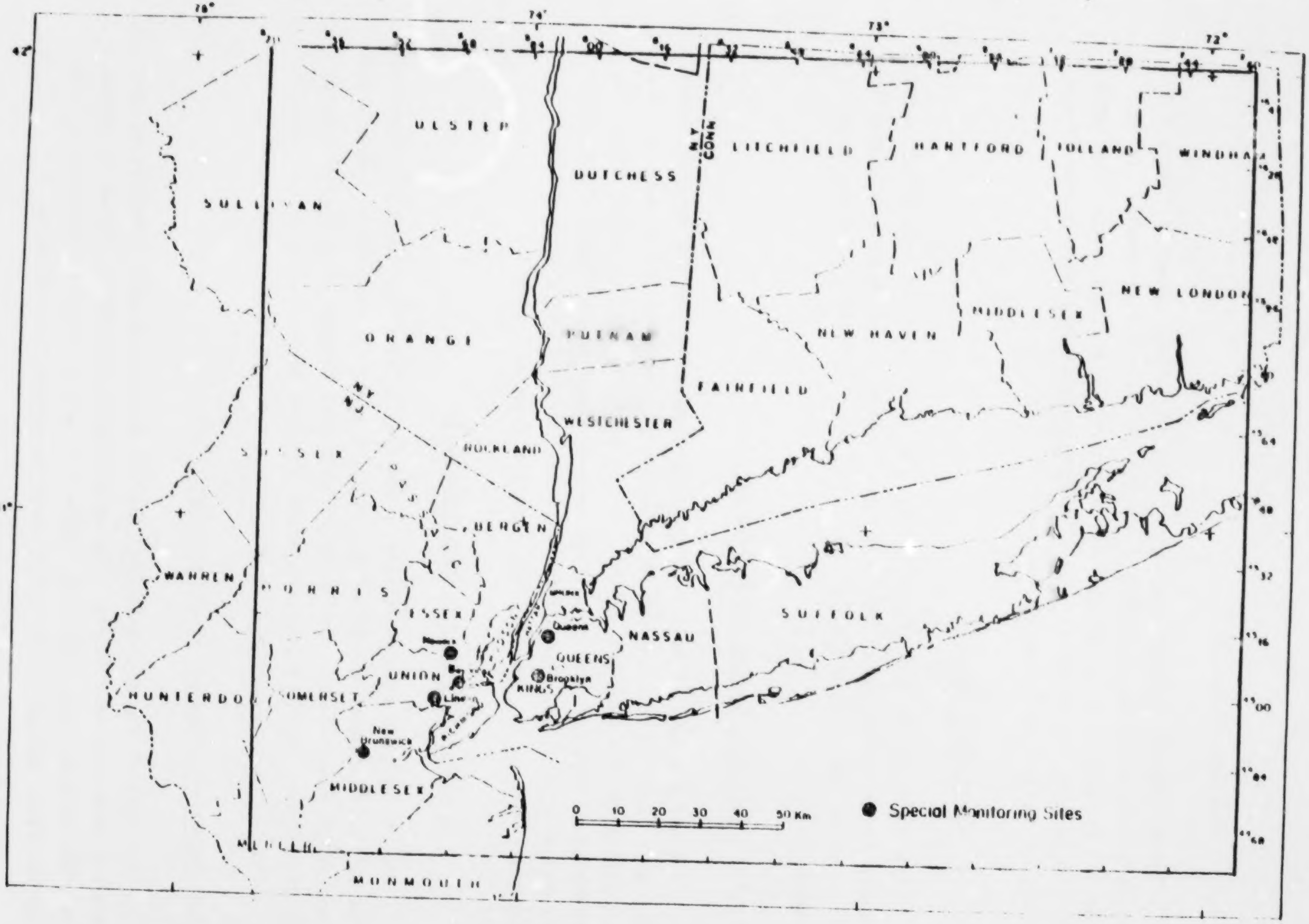
HARTFORD
Hartford
TOLLAND
Stafford
WINDHAM
NY
CONN
Middletown
MIDDLESEX
NEW LONDON
ORANGE
PUTNAM
Danbury
NEW HAVEN
FAIRFIELD
Derby
New Haven
NY
NJ
WESTCHESTER
ROCKLAND
SUSSEX
PASSAIC
Bridgeport
Stratford Lighthouse
White Plains
Greenwich
BERGEN
Dumont
Mamaroneck
Stony Brook
WARREN
MORRIS
Chester
Hempstead
SUFFOLK
ESSEX
Orange
Newark
Queens College
NASSAU
Mabel Dean
QUEENS
Babylon
Eisenhower Park
UNION
Bayonne
HUNTERDON
SOMERSET
Plainfield
Linden
KINGS
Sommerville
Sutton Wagner
Sheepshead Bay
New Brunswick
MIDDLESEX
MERCER
Marlboro
MONMOUTH
0 10 20 30 40 50 Km
State Air Monitoring Sites
Special Monitoring Sites

Figure 1.2 Geographic Distribution of Ozone Monitoring Sites in the Modeling Region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NEW LONDON
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ROCKLAND
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PASSAIC
BERGEN
WARREN
MORRIS
ESSEX
UNION
HUNTERDON
SOMERSET
MIDDLESEX
MONMOUTH
MERCER
NASSAU
QUEENS
KINGS
SUFFOLK
Queens
Brooklyn
Linden
New Brunswick
0
10
20
30
40
50 Km
Special Monitoring Sites

Figure 3.3 Geographic Distribution of NMHC Monitoring Sites in the Modeling Region

3.2.3 Nitrogen Oxides (NO_x)

The monitoring stations reporting nitrogen oxides, shown in Figure 3.4, were all located in the southwestern portion of the modeling domain. In addition to the data from 15 to 20 routine monitoring stations, data from three other sites from the NECRMP study were used to estimate the distribution of the oxides of nitrogen in the modeling domain.

3.2.4 Carbon Monoxide (CO)

The majority of the CO monitoring stations, shown in Figure 3.5, were located in the urban areas. The data from these stations were used to provide estimates of the distribution of the pollutant concentrations in the modeling domain.

3.2.5 Ancillary Ambient Air Quality Data

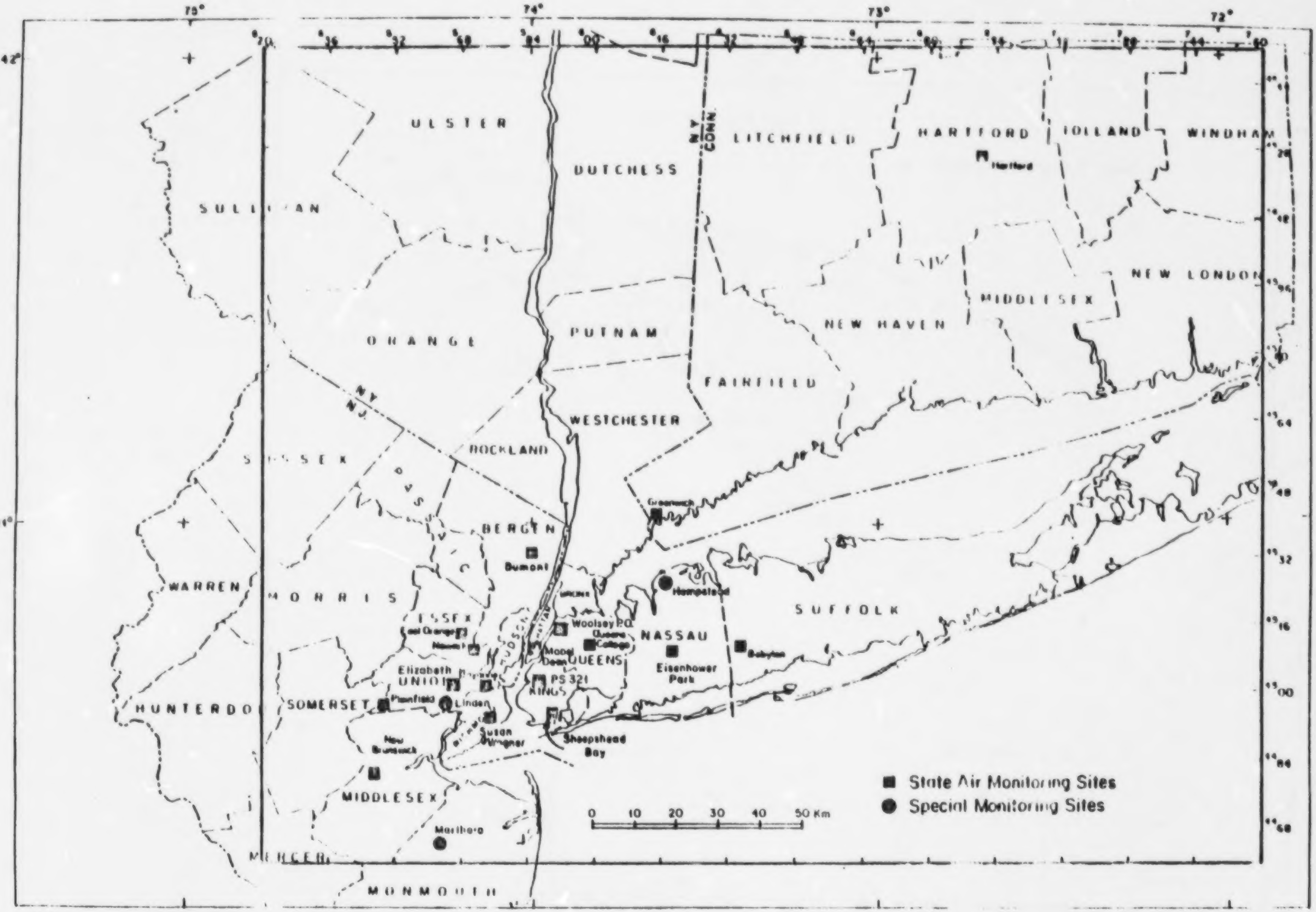
Ambient air quality data from stations located outside the domain, listed in Table 3.1, were assembled to provide the required input data at the boundaries of the modeling domain. Also, aircraft data collected under the NECRMP study were utilized to provide information on the pollutant distribution in the vertical plane. The flight paths over the domain consisted of horizontal traverses with spirals at the fixed locations shown in Figure 3.6.

3.2.6 Surface and Upper Air Meteorological Data

The routine NWS station network in the domain, shown in Figure 3.7, provided the surface wind speed and direction, relative humidity, atmospheric pressure and temperature measurements. The upper air data were obtained from the NWS station at JFK Airport, New York City and NECRMP stations shown in Figure 3.7, and the solar radiation data were taken from Flemington and Marlboro in New Jersey.

3.3 Model Input Parameters - Meteorological

For each of the days selected, the UAM simulations were commenced at 0400 Hrs and terminated at 2000 Hrs. The meteorological parameters needed to execute the UAM program are listed in Table 3.2 and a brief description of the methodologies adopted for obtaining these parameters is given below.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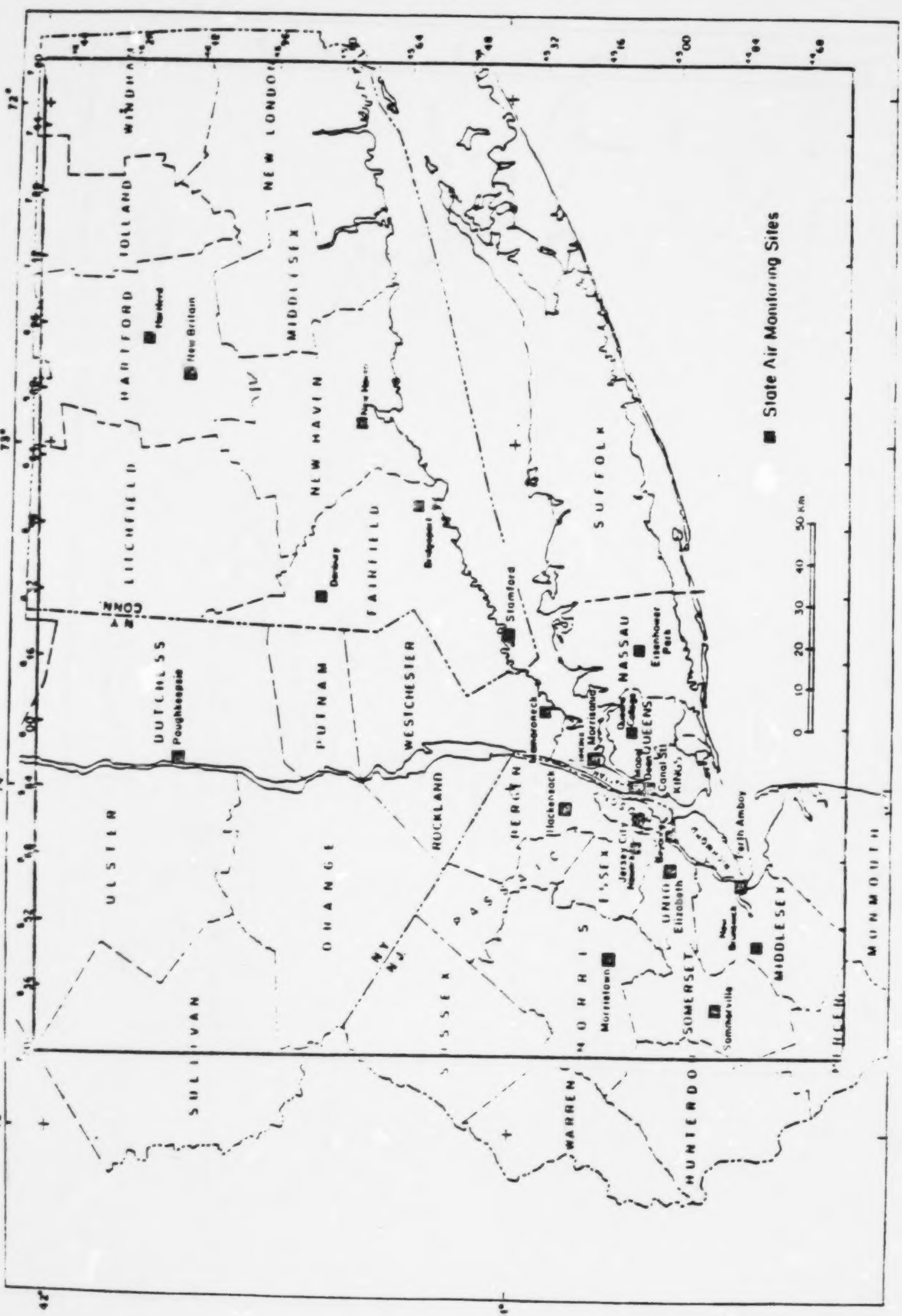
LITCHFIELD
HARTFORD
Hartford
TOLLAND
WINDHAM
NY
CONN
ORANGE
PUTNAM
NEW HAVEN
MIDDLESEX
NEW LONDON
FAIRFIELD
NY
NJ
SUSSEX
ROCKLAND
WESTCHESTER
Greenwich
PAS
BERGEN
Dumont
WARREN
MORRIS
Hempstead
SUFFOLK
ESSEX
East Orange
Newark
Woolsey P.O.
Queens College
NASSAU
Babylon
Mabel Dean
QUEENS
Eisenhower Park
Elizabeth
UNION
PS 321
KINGS
HUNTERDON
SOMERSET
Plainfield
Linden
Susan Wagner
Sheepshead Bay
New Brunswick
MIDDLESEX
Marlboro
MERCER
MONMOUTH
State Air Monitoring Sites
Special Monitoring Sites
0
10
20
30
40
50 Km

Figure 3.1 Geographic Distribution of NO/NO$_2$ Monitoring Sites in the Modeling Region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SULLIVAN
ORANGE
DUTCHESS
Poughkeepsie
PUTNAM
WESTCHESTER
ROCKLAND
BERGEN
Hackensack
Mamaroneck
Morrisania
Queens College
QUEENS
Canal St.
KINGS
NASSAU
Eisenhower Park
SUFFOLK
ESSEX
Jersey City
Newark
Bayonne
UNION
Elizabeth
Perth Amboy
MIDDLESEX
New Brunswick
SOMERSET
Sommerville
MORRIS
Morristown
SUSSEX
PASSAIC
WARREN
HUNTERDON
MONMOUTH
NY
NJ
CONN
LITCHFIELD
FAIRFIELD
Danbury
Bridgeport
Stamford
NEW HAVEN
New Haven
HARTFORD
Hartford
New Britain
MIDDLESEX
TOLLAND
WINDHAM
NEW LONDON
State Air Monitoring Sites
0
10
20
30
40
50 km
42°
41°
74°
73°
72°
75°

Figure 3.5 Geographic Distribution of CO Monitoring Sites in the Modeling Region

TABLE 3.1

Ambient Air Quality Monitoring Stations Located Outside the Modeling Region

Pennsylvania	New Jersey	New York	Rhode Island	Massachusetts
Scranton	Ancora	Binghamton	Kent County	Agawam
Allentown	Flemington	Rensselaer		Medfield
	Phillipsburg			Sudbury
	McGuire AFB			Easton
	Trenton			Somerville
	Nacotee Creek			Pittsfield
	Chester			

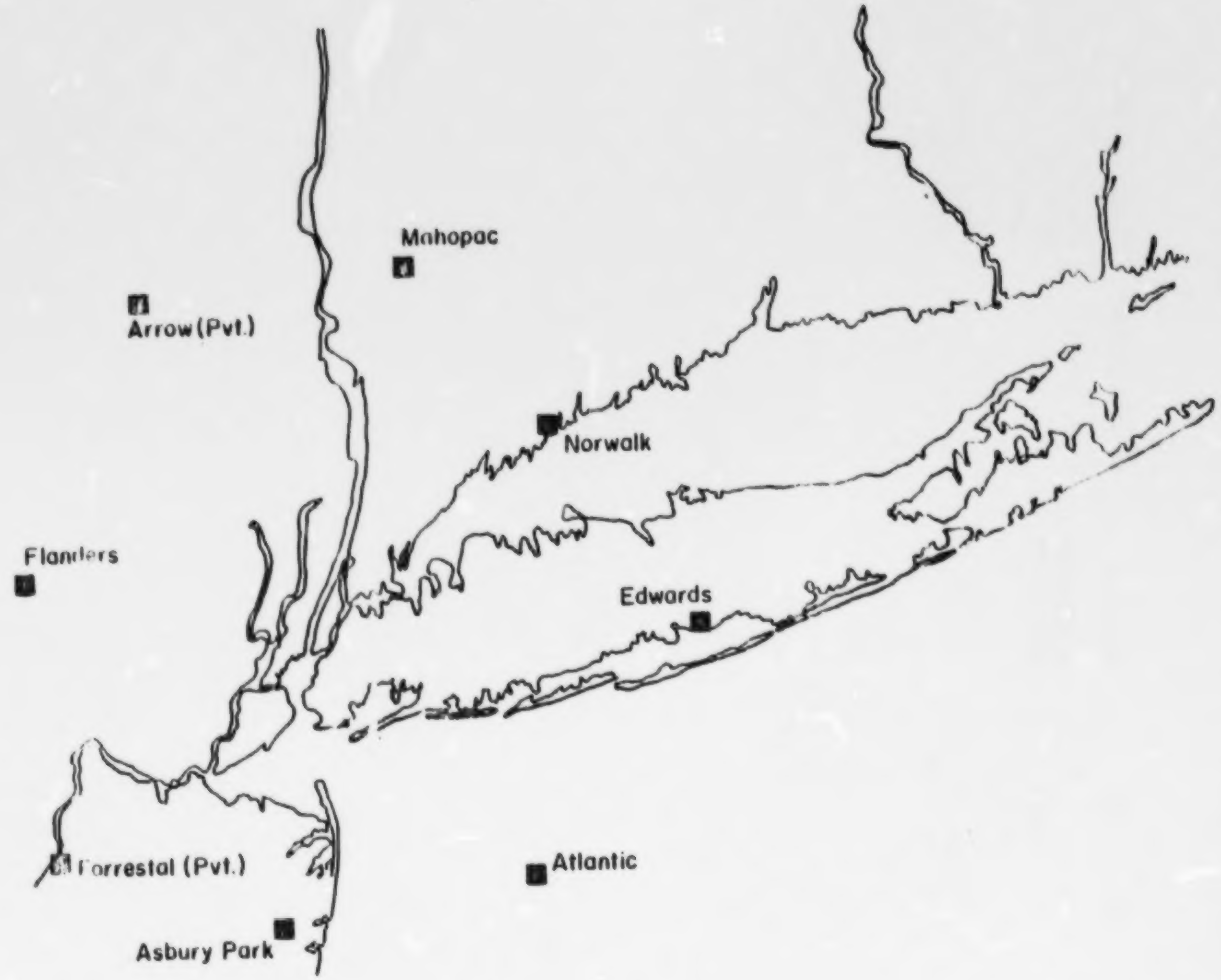
Mahopac
Arrow (Pvt.)
Norwalk
Flanders
Edwards
Forrestal (Pvt.)
Atlantic
Asbury Park

Figure 3.6 Aircraft Spiral Sites in the Modeling Region

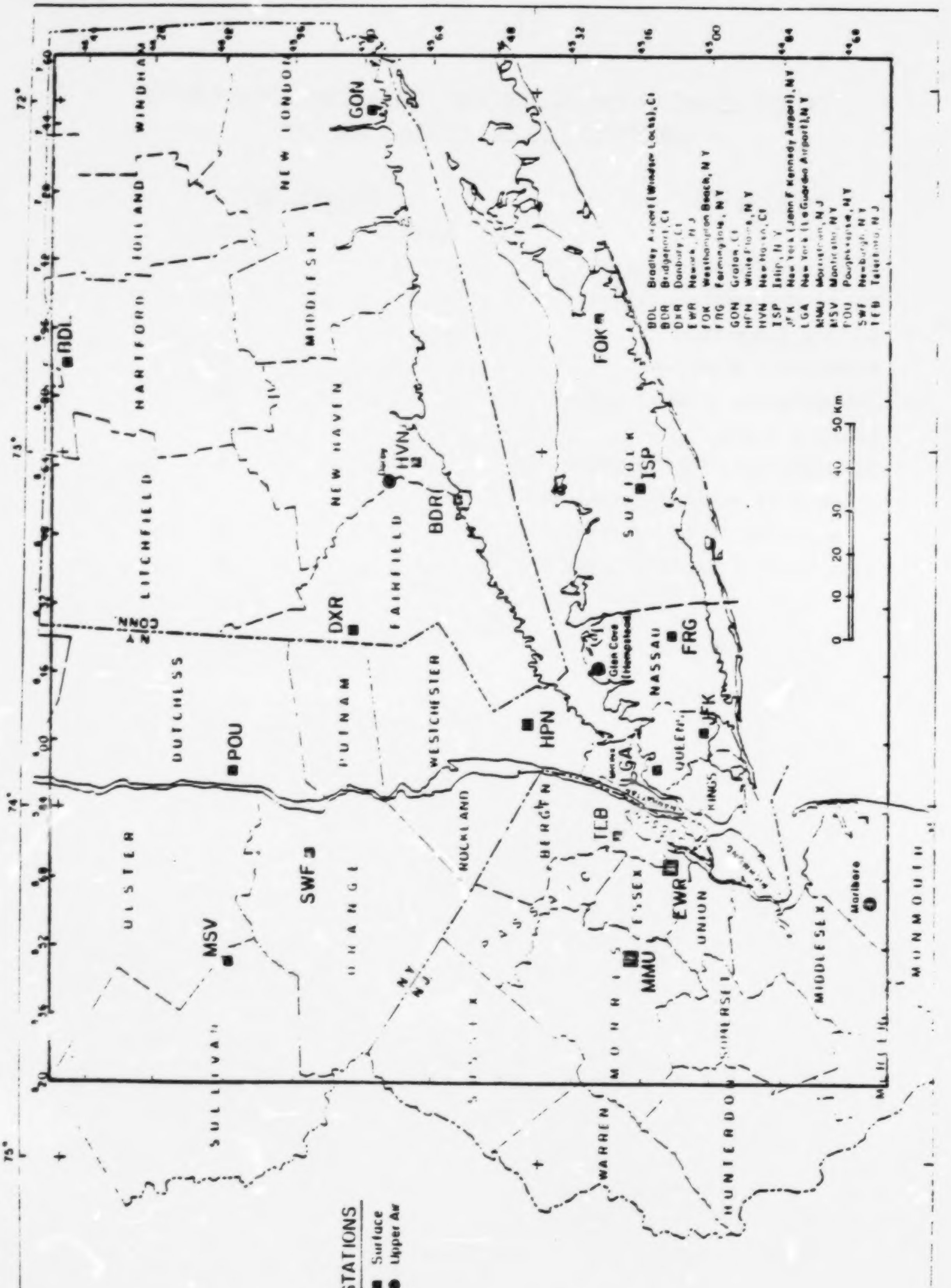
STATIONS
■ Surface
● Upper Air
BDL Bradley Airport (Windsor Locks), Ct
BDR Bridgeport, Ct
DXR Danbury, Ct
EWR Newark, N J
FOK Westhampton Beach, N Y
FRG Farmingdale, N Y
GON Groton, Ct
HPN White Plains, N Y
HVN New Haven, Ct
ISP Islip, N Y
JFK New York (John F Kennedy Airport), N Y
LGA New York (La Guardia Airport), N Y
MMU Morristown, N J
MSV Monticello, N Y
POU Poughkeepsie, N Y
SWF Newburgh, N Y
TEB Teterboro, N J
0 10 20 30 40 50 Km
SULLIVAN
ULSTER
DUTCHESS
ORANGE
PUTNAM
ROCKLAND
WESTCHESTER
LITCHFIELD
HARTFORD
TOLLAND
WINDHAM
NEW LONDON
MIDDLESEX
NEW HAVEN
FAIRFIELD
BERGEN
ESSEX
UNION
MORRIS
SOMERSET
HUNTERDON
WARREN
MIDDLESEX
MONMOUTH
KINGS
QUEENS
NASSAU
SUFFOLK
NY
CONN
NY
NJ
MSV
SWF
POU
DXR
BDR
HVN
BDL
GON
HPN
LGA
TEB
EWR
MMU
JFK
FRG
ISP
FOK
Glen Cove (Hempstead)
Marlboro
42°
41°
75°
74°
73°
72°

Figure 3.7 Surface and Upper Air Meteorological Stations in the Modeling Region

TABLE 3.2

Meteorological Parameters Included in the Urban Airshed Model and Their Variation in Space and Time

Parameter	Variability	
	Space	Time
Diffusion break (mixing height)		t
Top of the modeling region		t
Surface temperature	x, y	t
Atmospheric pressure		t
Concentration of water vapor		t
Exposure Index		t
NO_2 Photolysis Rate constant		t
Temperature gradient above and below the diffusion break		t
Wind field in terms of u and v		t

3.3.1 Diffusion Break (Mixing Height)

The available data for the determination of the hourly mixing heights included rawinsonde temperature soundings and vertical profiles of temperature and pollutant concentration measured by aircraft obtained at the locations shown in Figures 3.6 and 3.7. The methods by which the hourly mixing heights were derived included those of Benkeley-Schulman (1979), Nieuwstadt (1981), and Garrett (1981). Also, the information on the vertical gradients in the ozone concentration and the extent of ozone scavenging were utilized in estimating the spatially invariant hourly mixing heights for each of the selected days.

3.3.2 Top of the Modeling Region

An hourly variable height for the region top was selected for this study. The region top was assumed to rise at a rate slower than that of the mixing height in the morning hours, and by midday both of them became equal. The region top was assumed to remain constant at that height, while the mixing height decreased in the late afternoon hours. The top of the modeling region was set at a minimum height of 1000 m with a minimum depth of 500 m for the layers between the top of the modeling region and the level below. Figure 3.8 shows schematically the diurnal profile of the top of the modeling region along with mixing heights for the modeling domain.

3.3.3 Surface Temperature

The distribution of the surface temperature within the domain was derived through an inverse-distance-squared weighting interpolation scheme utilizing the measurements available at the NWS stations shown in Figure 3.7 for each hour of the model simulation.

3.3.4 Atmospheric Pressure

Sea-level atmospheric pressure values, obtained from the NWS stations shown in Figure 3.7, for each hour are averaged to yield a value over the domain for that hour.

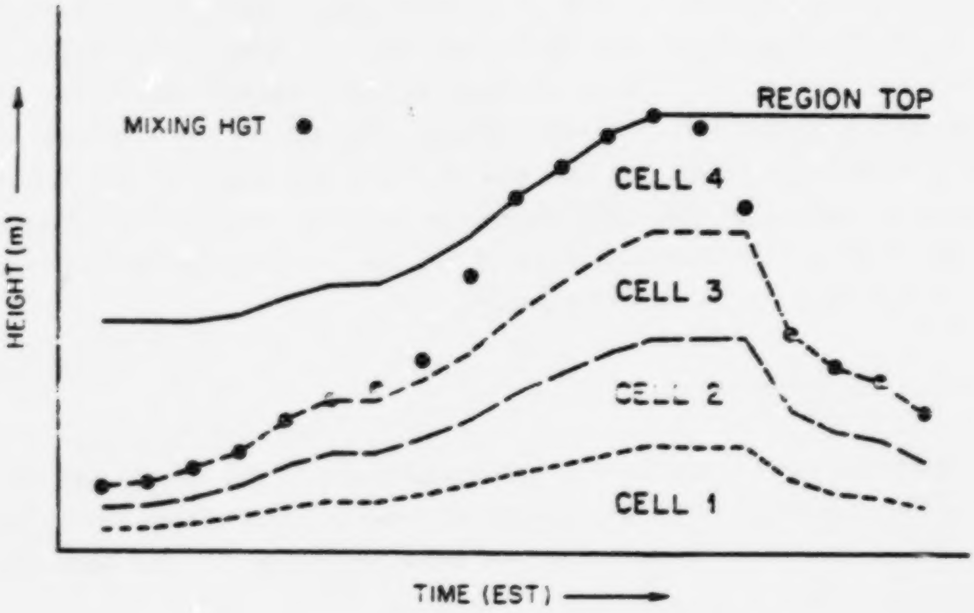

Figure 3.8 Schematic Representation of the Typical Diurnal Profile for the Region Top, Mixing Height and the Vertical Cell Height

3.3.5 Concentration of Water Vapor

Following Byers (1971) and Hull (1974) the specific humidity of saturation, q_s, was obtained as follows:

$$q_s \text{ (grams of water/grams of air)} = 0.622\, e_s/(P-0.37\, e_s)$$

where e_s, the saturation vapor pressure (mb) is given by

$$e_s = E_s \exp(AT/\lambda)$$

where $\lambda = (T + 273.16-B)$

$A = 17.2693882$

$B = 35.86$

$E_s = 6.1078$

P = atmospheric pressure (mb)

T = dew point temperature (°C)

In this study, the specific humidity of saturation for each hour was calculated from the data collected at the NWS station located at JFK airport in New York City, which was then multiplied by 10^6 to yield the water vapor concentration in ppm as a representative value for the domain.

3.3.6 Exposure Index

This parameter is a measure of near ground level stability due to surface heating or cooling and is estimated from insolation as shown in Table 3.3. In this study, the data utilized to estimate the exposure index included the solar radiation data from the Flemington and Marlboro sites in the southwestern part of New Jersey and the hourly sky cover conditions reported from the NWS stations shown in Figure 3.7. An estimate of the exposure index for each hour was made using these data as well as synoptic weather information.

3.3.7 Diurnal Photolysis Rate Constant

A computer program that incorporates the data of Demerjian, et. al., (1980) was used to calculate layer-averaged NO_2 photolysis rate constants based upon the latitude, longitude, month, day and time of day, mixing height, and solar radiation data. Assuming clear sky conditions and using the mixing height information, the layer-averaged NO_2 photolysis rate constants were obtained for the modeling domain.

TABLE 3.3

Daytime Insolation and Nighttime Cloudiness Conditions as a Function of Exposure Index

		Exposure Index
	Strong	3
Insolation	Moderate	2
	Slight	1
	Heavy overcast day or night	0
Night time	≥ 4/8	-1
Cloud cover	≤ 3/8	-2

3.3.8 Temperature Gradient

The temperature gradients above and below the diffusion break were calculated from the temperature soundings available at one or more locations shown in Figure 3.7. The gradients for each hour were estimated by averaging the measured profiles at increments of 100 m above and below the diffusion break. For those hours for which data were not available, the gradients were obtained through linear interpolation from adjacent hours.

3.3.9 Wind Field

UAM requires the specification of a gridded three-dimensional flow field. Attempts were made to generate a gridded wind field based upon the available surface and upper air data from the stations shown in Figure 3.7, using the Clark and Eskridge (1977) non-divergent algorithm. However, the spatial representativeness of the available upper air observations for the entire modeling domain was found to be questionable because of the influence of land-sea breeze circulations. Application of a bi-cubic splines interpolation technique to the surface level winds produced too much smoothing in the derived wind field. Thus, it was decided to use only the surface based observations and generate the three-dimensional non-divergent gridded wind field, assumed invariant in the vertical direction. However, examination of such a wind field and trajectory paths revealed an undue influence from the coastal NWS stations which appear to be affected significantly by the land-sea breeze interactions. Hence, a spatially constant but temporally varying vector-averaged wind speed and direction for each hour of the simulation were considered to be a reasonable compromise for capturing the transport characteristics prevailing in the modeling domain.

3.3.10 Initial Air Quality and Region Top Concentrations

The following procedures were adopted to obtain the gridded pollutant distribution at the surface and in the vertical. For each of the pollutants the concentrations measured at the ambient air quality monitoring stations shown in Figures 3.2 to 3.5 for the period 0300 and 0400 Hrs were averaged and formed the basis for generating gridded surface concentrations. The methods consisted of an inverse-distance-squared weighting scheme or the population distribution as a surrogate parameter, particularly when there were very few or a limited number of surface stations from which data were available to make a meaningful interpolation over the modeling domain. For the grids over the Atlantic Ocean, the pollutant concentrations were assumed to be the same as those in layer 4 and assumed to be uniformly distributed in the vertical.

The pollutant measurements made with the aircraft over the domain were used to provide the concentration estimates at the top of the modeling domain for each of the pollutants as well as for the layer 4. For the intermediate levels between the surface and the base of the layer 4, the concentrations were determined as follows. If the grid cell was classified as urban, the concentrations were assumed to be uniform from the surface up to the base of layer 4; and if it was rural, the concentrations were obtained using the gradient determined from the aircraft spiral data. This is shown schematically in Figure 3.9.

Listed in Table 3.4 are the CBII chemical speciation factors which were developed from the ambient NECRMP data base and applied to the NMHC concentrations in this study. The NO_2-NO ambient concentrations were assumed to be in the ratio of 2 to 1.

3.3.11 Boundary Concentrations

The surface concentrations along the boundaries for each hour were estimated based upon measurements from the monitoring stations listed in Table 3.1. Attempts were made to take into account the wind direction for each hour in arriving at the surface boundary concentrations considering the location of the monitoring station and availability of data. The vertical gradients of the pollutants determined from the aircraft measurements were applied to all four sides and used to determine the concentrations in the vertical up to the 3rd layer. In those cases where the ozone concentrations in any one of the surface boundary grids was determined to exceed that of the region top value before the mixing height entrenches into the layer 4, such grids were assumed to be uniformly mixed up to the layer 3. In the case of the 4th layer, it was assumed

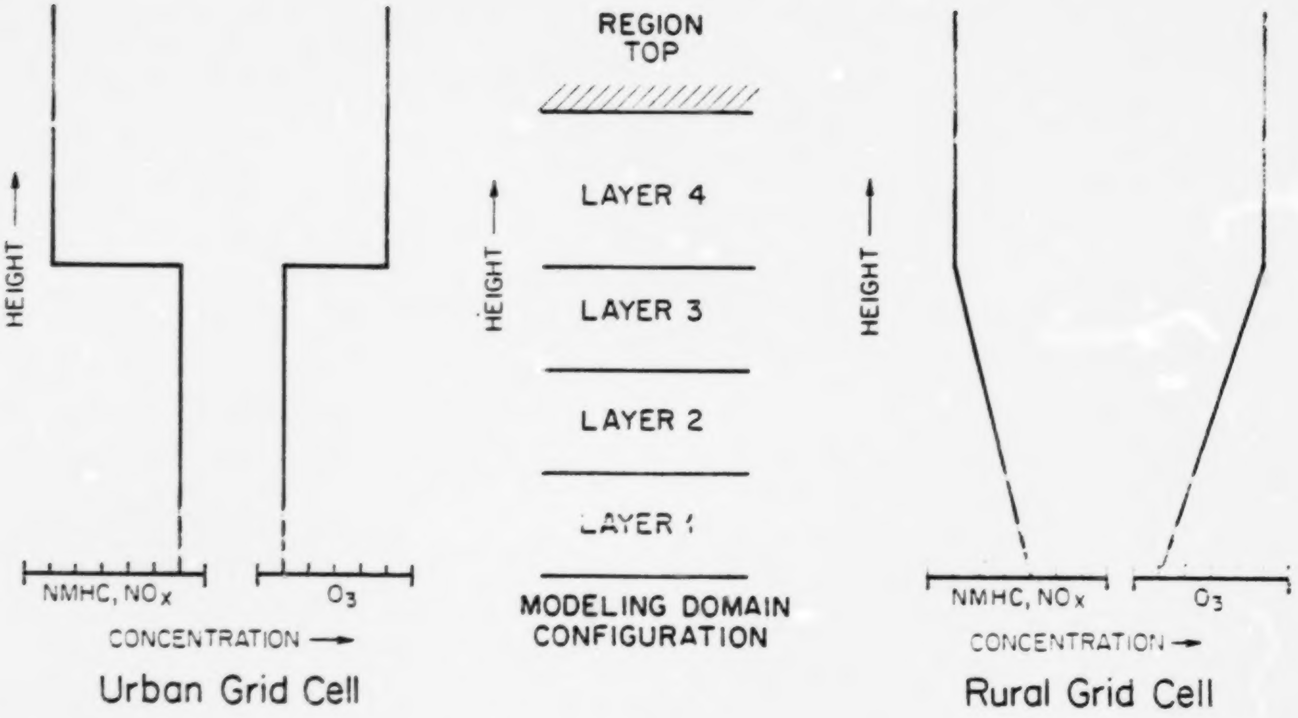
REGION TOP
LAYER 4
LAYER 3
LAYER 2
LAYER 1
HEIGHT
NMHC, NO_x
O_3
CONCENTRATION
Urban Grid Cell
MODELING DOMAIN CONFIGURATION
Rural Grid Cell

Figure 3.9 . Schematic of the Initial Pollutant Distribution in the Vertical Plane for Urban and Rural Grid Cells in the Modeling Region that the pollutant concentrations are the same as those adopted for the top of the modeling region. This procedure was adopted for those hours for which the diffusion break (mixing height) was at or below the base of the layer 4. For all subsequent hours it was assumed that the pollutants are well-mixed throughout the layer from the surface up to the fourth layer. In the case of the grids over the Atlantic Ocean. it was again assumed that the concentrations were at the same levels as those of the layer 4 with no vertical gradient. The NO_2-NO mix at the boundaries was also assumed to be in the ratio of 2 to 1 and the NMHC concentrations were speciated as follows - 6% carbonyls (CARB). 3% olefins (OLE). 24% aromatics (ARO). 58% paraffins (PAR), and 3% ethylenes (ETH).

TABLE 3.4

CBII Chemical Speciation Factors as a Function of NMHC Concentration

NMHC (ppb C)	CARB	OLE	ARO	PAR	ETH
<50	2	0	25	51	3
50-100	6	3	24	58	3
<100	9	5	22	63	3

CHAPTER 4

EMISSIONS

4.1 1980 Emissions Inventory Development

The UAM requires a gridded emissions inventory for each hour simulated, speciated into the hydrocarbon classes used in the Carbon Bond II Chemical mechanism. Since each state covered by the modeling domain has a different emissions inventory system, a new emissions data management system was required to merge these data into a form compatible with UAM. To assist in this task, NYSDEC contracted with Engineering Science (ES), Fairfax, VA for the installation of computer codes required for this purpose. ES had developed similar codes for the U.S. Environmental Protection Agency for the Philadelphia metropolitan area study (USEPA, 1982).

The system of programs accepts emissions data in the format used by the National Emission Data System (NEDS). It also makes use of modules from the Emissions Inventory System (EIS), which provides emissions calculation procedures. These procedures allow a user to estimate emissions using process rates or activity levels and emission factors. The emission factors are stored in a user-maintained table which is arranged by Source Classification Code (SCC) and pollutant identification number.

The installed system provides the means to disaggregate annual emission estimates to an hourly basis using specific or typical operating schedules, and to speciate total hydrocarbons into several classes depending on the composition of emissions from the source category (see Appendix A). After performing these calculations, the system formats the data to the specifications of UAM.

The system is designed for the processing of four types of emission sources: major and minor point sources, area sources, and mobile sources. Major and minor point sources are those sources which emit significant amounts from smokestacks or other readily identifiable emission points and for which detailed operating data are available. Area sources include residential emissions and others which are too small and too numerous to handle individually. Mobile sources are generally considered to be motor vehicles on established roadways.

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In this study, major point sources were defined as those with annual emissions greater than 100 tons and a stack height greater than 65 meters and the remaining were classified as minor point sources and are individually formatted by the system. However, minor point sources falling within a grid were combined due to the computational limitations imposed by UAM model. Area source emissions were calculated and maintained separately for up to 54 source categories and combined within each grid cell. Mobile source emissions are generally tabulated by grid cell. The installed system handles all four source categories and performs the necessary combinations. In addition, other modules have been provided for the conversion of data from NEDS to EIS format, allocation of county-level area source data to the grid cell level and for calculation of area source emissions. Figure 4.1 illustrates schematically the flow of data through the system. Once the data are in the EIS format, tables are developed consisting of factors organized by SCC that indicate the seasonal, daily, and hourly variations in emission rates and proportion of the total hydrocarbons into the corresponding hydrocarbon category. The program performs a simple multiplication of the annual estimate of each pollutant and the appropriate factors to yield 24 hourly emission rates per source. A post-processing program takes the factored data and formats it to the specifications of UAM. Emissions from mobile sources, which are not stored in EIS format and which have been prepared on an hourly basis, require a separate factoring and formatting program.

Unfortunately, the available data are seldom in the EIS format that is required as input to the processing programs. For example, point source data may be obtained more readily in the NEDS format, while the area source activities are tabulated at the county level instead of at the grid-cell level. For this reason, some additional computer codes were used to distribute county-level activities to the grid cells, to calculate emission estimates based on activity levels and emission factors, and to re-arrange the data into EIS format.

Thus, the EIS programs convert point and area source data in NEDS format to EIS transactions, sort the transactions, insert emission factors into the transactions, calculate emission estimates if requested and create or modify an EIS master file, and create an emission factor table based on SCC.

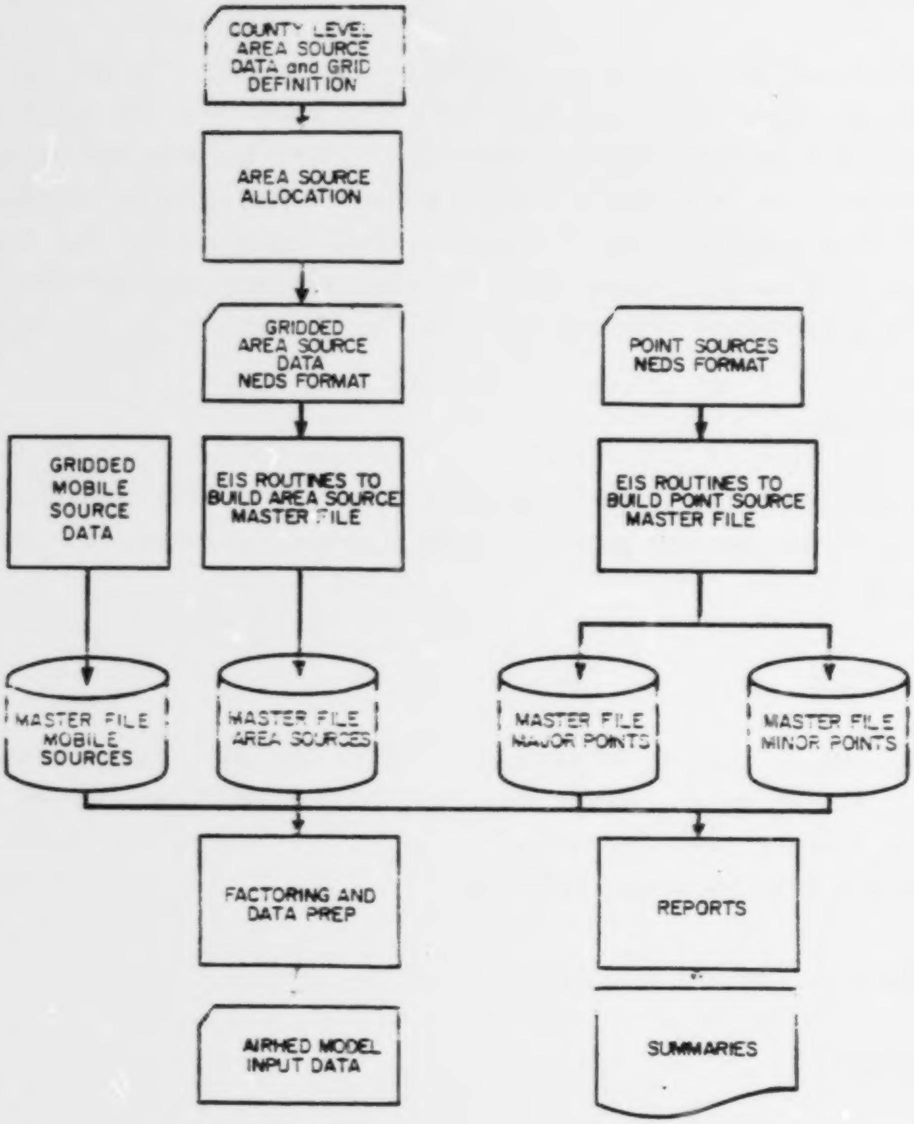

COUNTY LEVEL AREA SOURCE DATA and GRID DEFINITION
AREA SOURCE ALLOCATION
GRIDDED AREA SOURCE DATA NEDS FORMAT
POINT SOURCES NEDS FORMAT
GRIDDED MOBILE SOURCE DATA
EIS ROUTINES TO BUILD AREA SOURCE MASTER FILE
EIS ROUTINES TO BUILD POINT SOURCE MASTER FILE
MASTER FILE MOBILE SOURCES
MASTER FILE AREA SOURCES
MASTER FILE MAJOR POINTS
MASTER FILE MINOR POINTS
FACTORING AND DATA PREP
REPORTS
AIRHED MODEL INPUT DATA
SUMMARIES

Figure 4.1 Overview of the Emissions Data Management System

Each State was responsible for collecting and preparing the necessary data for processing by the ES programs. A description of the procedures used for each generating State's inventory is provided below.

4.2 Connecticut 1980 Emissions Inventory

4.2.1 Area Sources

Connecticut's available emission inventory was in NEDS format on a state-designed grid system. NEDS activity levels were summed into the grids by Connecticut Department of Environmental Protection (CTDEP) and provided to New York State Department of Environmental Conservation (NYSDEC). Also provided were the appropriate emission factors based on AP-42 (USEPA, 1984) for each source category. ES programs are then used to process the data into UAM format, and in Table 4.1 emissions are listed by SCC category for 1980.

4.2.2 Point Sources

CTDEP provided their point source emission inventory in NEDS format. ES programs are applied to separate major and minor sources and process the data into proper format for UAM.

4.2.3 Mobile Sources

Connecticut mobile source emissions of VOC, CO, NO_x (kg/day) were calculated using MOBILE3 model. NYSDEC developed factors which are applied to daily values to convert these emissions to an hourly format. ES programs processed these data into the proper UAM format.

4.3 New Jersey 1980 Emissions Inventory

4.3.1 Area Sources

The New Jersey Department of Environmental Protection (NJDEP) provided the data necessary to create a UAM compatible area source emissions inventory. Activity levels for each source category were given for each NJ county in the

TABLE 4.1

Connecticut 1980 Area Source Emissions by SCC

DESCRIPTION	SCC	ANNUAL(tons) VOC	ANNUAL(tons) NOx	DAILY (kg) VOC	DAILY (kg) NOx	MODEL SPECIES(g moles) CARB	OLE	ARO	PAR	ETH	NO	NO2
RESIDENTIAL FUEL-ANTH.	90100111	85	38	8	4	10	10	3	169	0	78	3
RESIDENTIAL FUEL-DIST.	90100330	245	6,525	47	643	765	0	0	1,666	0	10,491	3,497
RESIDENTIAL FUEL-RESID.	90100440			0	0	0	0	0	0	0	0	0
RESIDENTIAL FUEL-NAT GAS	90100500	72	1,612	69	1,413	183	0	15	1,434	0	26,727	3,994
RESIDENTIAL FUEL-WOOD	90100600	19,392	1,354	0	0	0	0	0	0	0	0	0
COMM/INST FUEL-DIST.	90200330	20	2,028	58	3,025	944	0	0	2,057	0	65,094	658
COMM/INST FUEL-RESID.	90200440	18	1,164	46	1,736	871	0	0	1,054	0	37,362	377
COMM/INST FUEL-NAT GAS	90200500	32	889	84	2,158	225	0	18	1,765	0	45,502	1,407
INDUSTRIAL FUEL-DIST.	90300330		383	0	846	0	0	0	0	0	17,662	736
INDUSTRIAL FUEL-RESID.	90300440	1	1,817	4	4,015	72	0	0	87	0	85,974	1,309
INDUSTRIAL FUEL-NAT GAS	90300500	4	674	13	2,062	35	0	3	278	0	42,368	2,466
SURFACE COATING-ARCHITECT	90401200	7,078		26,523	0	131,729	0	31,963	1,300,525	0	0	0
SURFACE COATING-AUTO REF	90401300	2,862		9,834	0	48,841	0	11,851	482,189	0	0	0
SURFACE COATING-INDUSTRIAL	90501100	8,518		29,349	0	105,875	0	23,788	1,144,016	0	0	0
DEGREASING-COLD CLEANING	90501200			0	0	0	0	0	0	0	0	0
DEGREASING-OPEN TOP CONV	90501300	3,172		9,108	0	0	0	0	0	32,202	0	0
OFF HW VEH-GASOLINE FARM	90600700			0	0	0	0	0	0	0	0	0
OFF HW VEH-GASOLINE CONS	90600800	2,663	2,049	11,161	8,741	14,391	36,847	21,453	311,084	47,472	180,530	9,502
OFF HW SMALL ENG GASOLINE	90600900			0	0	0	0	0	0	0	0	0
OFF HW VEH-DIESEL CONST.	90700800	97	1,549	414	6,608	1,683	394	739	14,349	1,581	129,294	14,366
DIESEL RAIL LOCOMOTIVES	90702400	337	1,360	920	3,714	3,104	2,789	620	46,873	0	72,658	8,073
AIRCRAFT-MILITARY	90803100	193	65	501	160	911	228	979	23,663	715	3,379	105
AIRCRAFT-CIVIL	90803200	118	4	214	7	390	98	419	10,129	306	146	5
AIRCRAFT-COMMERCIAL	90803300	533	468	1,383	1,154	2,515	631	2,704	65,349	1,976	24,329	752
VESSELS-RESIDUAL	90900440		19	0	47	0	0	0	0	0	998	20
VESSELS-DIESEL	90904230	80	430	225	1,060	913	214	401	7,789	858	22,123	922
VESSELS-GASOLINE	90904430	3,939	102	14,134	352	17,903	45,840	26,689	387,010	59,059	7,771	383
CUTBACK ASPHALT	91000600	1,493		6,833	0	0	0	0	446,736	0	0	0
DRYCLEANING	91000800	2,791		8,014	0	0	0	0	276,331	0	0	0
PESTICIDE USE	91000900			0	0	0	0	0	0	0	0	0
COMMERCIAL/CONSUMER SOLV	91002100	9,605		23,679	0	54,461	0	0	1,071,263	0	0	0
GRAPHIC ARTS	91002200	1,824		5,242	0	2,704	970	2,325	178,428	4,306	0	0
SMALL PROCESSES	91002300	1,660		5,719	0	20,633	0	4,636	266,419	0	0	0
GASOLINE MKTNG-OTHER	91002600	11,959		31,841	0	50,945	19,332	2,449	2,037,800	0	0	0
GASOLINE MKTNG-STAGE I	91005100)			0	0	0	0	0	0	0	0	0
GASOLINE MKTNG-STAGE II	91005200)			0	0	0	0	0	0	0	0	0
STRUCTURE FIRES	91308400	211	21	520	52	788	2,050	158	14,273	0	957	169
CONNECTICUT TOTALS		79,002	22,551	186,142	37,798	460,889	109,402	131,213	8,092,736	148,477	772,943	48,743

modeling domain. Appropriate emission factors were also provided. Since most area source emissions are based on population, the same basis was used for dividing these emissions into the modeling grid. NJDEP supplied 1980 U.S. Census population data for each municipality and the percentage of the municipality located in each grid. Factors were then developed to apportion total county emissions into each grid. If a grid contained emissions from one or more counties and/or states, the emissions were combined during a later processing operation. The ES programs were applied and in Table 4.2 are summarized the area source emissions for 1980 by SCC category.

4.3.2 Point Sources

New Jersey's point source data were in a format that could not readily be converted to the EIS format. Therefore, it was determined that an emission inventory prepared for the NECRMP was compatible with the ES programs. Using this NECRMP inventory, the ES programs were applied to separate major and minor sources and the data was processed into proper UAM format.

4.3.3 Mobile Sources

NJDEP provided mobile source VOC emissions (kg/day) using MOBILE3, for each county in the modeling region. Utilizing the population distribution, these county-wide emissions were allocated to the corresponding grids using the ES programs. Emissions of NO_y and CO were then obtained by scaling these VOC data using composite emission factors (g/mile) for each of these pollutants. NYSDEC developed factors which were applied to daily values to create hourly emission levels. Once on a gridded basis, ES programs processed the mobile emissions into the UAM format.

4.4 New York 1980 Emissions Inventory

4.4.1 Area Sources

NYSDEC developed the data necessary to use the ES programs for creating their area source emission inventory in UAM format. Activity levels for each source category were determined for each NY county in the modeling region. Appropriate emission factors were also assembled.

TABLE 4.2

New Jersey 1980 Area Source Emissions by SCC

DESCRIPTION	SCC	ANNUAL(tons) VOC	ANNUAL(tons) NOx	DAILY (kg) VOC	DAILY (kg) NOx	MODEL SPECIES(g-moles) CARB	OLE	ARO	PAR	ETH	NO	NO2
RESIDENTIAL FUEL-ANTH.	90100111	60	72	6	7	7	7	2	119	0	148	6
RESIDENTIAL FUEL-DIST.	90100130	461	8,395	89	828	1,439	0	0	3,135	0	13,497	4,499
RESIDENTIAL FUEL-RESID.	90100440	7	1,100	1	108	22	0	0	27	0	2,334	24
RESIDENTIAL FUEL-NAT GAS	90100500	238	4,692	227	4,113	605	0	49	4,742	0	77,794	11,624
RESIDENTIAL FUEL-WOOD	90100600	2	0	0	0	0	0	0	0	0	0	0
COMM/INST FUEL-DIST.	90200130	112	2,611	326	3,894	5,286	0	0	11,520	0	83,807	847
COMM/INST FUEL-RESID.	90200440	128	8,206	329	12,238	6,193	0	0	7,498	0	263,393	2,661
COMM/INST FUEL-NAT GAS	90200500	90	1,906	237	4,626	633	0	52	4,965	0	97,556	3,017
INDUSTRIAL FUEL-DIST.	90300130	54	1,484	233	3,279	3,776	0	0	8,229	0	68,436	2,851
INDUSTRIAL FUEL-RESID.	90300440	55	4,327	210	9,561	3,943	0	0	4,776	0	204,739	3,118
INDUSTRIAL FUEL-NAT GAS	90300500	24	2,008	80	6,144	213	0	17	1,669	0	126,223	7,346
SURFACE COATING-ARCHITECT	90401200	12,041	0	45,120	0	224,096	0	54,375	2,212,436	0	0	0
SURFACE COATING-AUTO REF	90401300	4,703	0	16,159	0	80,258	0	19,474	792,360	0	0	0
DEGREASING-COLD CLEANING	90501200	3,713	0	10,661	0	55,081	0	8,611	369,086	4,569	0	0
DEGREASING-OPEN TOP CONV	90501300	3,713	0	10,661	0	0	0	0	0	37,694	0	0
OFF HW VEH-GASOLINE FARM	90600700	0	0	0	0	0	0	0	0	0	0	0
OFF HW VEH-GASOLINE CONS	90600800	786	580	3,353	2,474	4,247	10,876	6,332	91,818	14,012	51,102	2,690
OFF HW SMALL ENG GASOLINE	90600900	982	596	4,407	2,674	5,582	14,292	8,321	120,661	18,413	55,234	2,907
OFF HW VEH-DIESEL CONST.	90700800	1,630	23,086	6,954	98,490	28,279	6,615	12,411	241,117	26,574	1,926,974	214,108
DIESEL RAIL LOCOMOTIVES	90702600	967	3,870	2,641	10,567	8,906	8,002	1,780	134,498	0	206,755	22,973
AIRCRAFT-MILITARY	90803100	31	1	80	2	146	37	157	3,801	115	52	2
AIRCRAFT-CIVIL	90803200	164	40	298	69	542	136	582	14,077	426	1,456	45
AIRCRAFT-COMMERCIAL	90803300	2,939	2,167	7,627	5,342	13,867	3,477	14,908	360,336	10,895	112,651	3,484
VESSELS-RESIDUAL	90900440	12	196	51	483	960	0	0	1,162	0	10,294	210
VESSELS-DIESEL	90904210	60	509	168	1,255	685	160	301	5,861	664	26,188	1,091
VESSELS-GASOLINE	90904410	266	410	954	1,415	1,209	3,096	1,802	26,135	3,988	29,228	1,538
CUTBACK ASPHALT	91000600	6,577	0	30,101	0	0	0	0	1,967,970	0	0	0
DRYCLEANING	91000800	2,825	0	8,111	0	0	0	0	279,697	0	0	0
PESTICIDE USE	91000900	588	0	4,059	0	0	0	7,935	175,286	0	0	0
COMMERCIAL/CONSUMER SOLV	91002100	15,594	0	38,443	0	88,420	0	0	1,739,227	0	0	0
GRAPHIC ARTS	91002200	1,976	0	5,679	0	2,929	1,051	2,519	193,297	4,665	0	0
SMALL PROCESSES	91002300	68,328	0	235,422	0	849,286	0	190,818	10,966,175	0	0	0
GASOLINE MKTNG-OTHER	91002500	0	0	0	0	0	0	0	0	0	0	0
GASOLINE MKTNG-STAGE I	91005100	341	0	908	0	1,453	551	70	58,106	0	0	0
GASOLINE MKTNG-STAGE II	91005200	12,488	0	33,249	0	53,199	20,187	2,558	2,127,941	0	0	0
STRUCTURE FIRES	91300500	7,333	1,460	18,078	3,599	27,391	71,255	5,478	496,012	0	66,508	11,737
NEW JERSEY TOTALS		149,288	67,716	486,921	171,173	1,468,651	139,741	338,553	22,423,737	121,995	3,424,369	296,778

As with the New Jersey data, population was used as the basis to distribute most county level emissions to the modeling grids. Two source categories were deemed to have more appropriate methods of disaggregation - Vessels and Aircraft emissions. Vessel emissions are restricted to waterways in each county and aircraft emissions are limited to those grids which contained airports. Individual airport activity levels obtained from the New York Metropolitan Transportation Council (NYMTC) are used to proportion the county emission totals into the appropriate grids. Population for each grid was calculated from 1980 US Census data. NYMTC provided this data at 1 km grids for most New York counties which are then summed into the appropriate UAM grids. NYMTC had no data for Sullivan and Ulster counties so the procedure which New Jersey followed was used to apportion those counties' emissions to the modeling grids. The ES programs were applied and the 1980 area source emissions from New York are listed in Table 4.3 by SCC category.

4.4.2 Point Sources

New York's point source data were also in a format that could not be converted to the EIS format. Therefore, NY data had to be processed independently and subsequently combined with that from the other states. A search of the NYSDEC Source Management System (SMS) identified those sources meeting the major point source criteria. Only utility boilers and one correctional facility boiler were classified as major point sources. All others were deemed minor point sources for this study.

A survey was sent to each utility requesting actual hourly electricity generation values for the five modeling days. The five hourly values were averaged and emissions calculated using the average 1980 heat rate (Btu/kwhr) and appropriate emission factors based on AP-42, unless unit specific factors were available. Hourly emissions from the correctional facility's boiler are calculated based upon operational data obtained from the unit's Certificate to Operate permit. Those hourly emissions from the major point sources were then divided into the UAM species and processed into the correct format. Only NO_x emissions are used for this exercise. VOC emissions from these boilers were deemed negligible and not included in the model.

TABLE 4.3

New York 1980 Area Source Emissions by SCC

DESCRIPTION	SCC	ANNUAL(tons) VOC	NOx	DAILY (kg) VOC	NOx	MODEL SPECIES(g-moles) CARB	OLE	ARO	PAR	ETH	NO	NO2
RESIDENTIAL FUEL-ANTH.	90100111	63	242	6	24	7	7	2	125	0	498	21
RESIDENTIAL FUEL-DIST.	90100330	909	16,704	175	1,647	2,836	0	0	6,182	0	26,856	8,952
RESIDENTIAL FUEL-RESID.	90100440	186	10,108	32	997	595	0	0	720	0	21,452	217
RESIDENTIAL FUEL-NAT GAS	90100500		9,417	0	8,255	0	0	0	0	0	156,134	23,330
RESIDENTIAL FUEL-WOOD	90100600	2,355	455	0	0	0	0	0	0	0	0	0
COMM/INST FUEL-BITUM.	90200222	36	148	4	18	5	5	2	90	0	384	16
COMM/INST FUEL-DIST.	90200330	155	3,912	451	5,834	7,315	0	0	15,943	0	125,566	1,268
COMM/INST FUEL-RESID.	90200440	225	12,443	579	18,558	10,887	0	0	13,180	0	399,391	4,034
COMM/INST FUEL-NAT GAS	90200500	37	1,636	98	3,971	260	0	21	2,041	0	83,736	2,590
INDUSTRIAL FUEL-DIST.	90300330	117	2,894	504	6,395	8,181	0	0	17,830	0	133,459	5,561
INDUSTRIAL FUEL-RESID.	90300440	48	3,574	183	7,898	3,441	0	0	4,166	0	169,110	2,575
INDUSTRIAL FUEL-NAT GAS	90300500	5	1,927	17	5,896	44	0	4	348	0	121,132	7,050
ON-SITE INCINERATION	90401100	24	34	75	107	114	297	23	2,069	0	0	0
SURFACE COATING-ARCHITECT	90401200	17,408		65,231	0	323,982	0	78,612	3,198,579	0	0	0
SURFACE COATING-AUTO REF	90401300	6,692		27,993	0	114,200	0	27,710	1,127,466	0	0	0
DEGREASING-COLD CLEANING	90501200	4,618		13,259	0	68,506	0	10,709	459,047	5,683	0	0
DEGREASING-OPEN TOP CONV	90501300			0	0	0	0	0	0	0	0	0
OFF HW VEH-GASOLINE FARM	90600700	827	324	1,924	754	2,437	6,239	3,632	52,677	8,038	15,564	819
OFF HW VEH-GASOLINE CONS	90600800	1,412	1,747	6,024	7,453	7,630	19,537	11,375	164,946	25,171	153,922	8,101
OFF HW SMALL ENG GASOLINE	90600900			0	0	0	0	0	0	0	0	0
OFF HW VEH-DIESEL FARM	90700700	529	5,665	1,230	13,177	5,004	1,171	2,196	42,664	4,702	257,808	28,645
OFF HW VEH-DIESEL CONST.	90700800	904	33,210	3,857	141,681	15,684	3,669	6,883	133,724	14,738	2,772,019	308,002
INDUSTRIAL EQUIP. - DIESEL	90702200	112	1,428	326	4,152	1,324	310	581	11,291	1,244	81,231	9,026
DIESEL RAIL LOCOMOTIVES	90702400	609	2,771	1,663	7,567	5,609	5,039	1,121	84,704	0	148,041	16,449
AIRCRAFT-MILITARY	90801100	1,745	1,376	4,528	3,392	8,233	2,064	8,852	213,946	6,469	71,531	2,212
AIRCRAFT-CIVIL	90801200	1,655	288	3,007	497	5,467	1,371	5,877	142,057	4,295	10,482	324
AIRCRAFT-COMMERCIAL	90801300	1,346	5,611	3,493	13,833	6,351	1,592	6,828	165,026	4,990	291,687	9,021
VESSELS-RESIDUAL	90900440	45	1,757	191	4,331	3,599	0	0	4,357	0	92,279	1,883
VESSELS-DIESEL	90900230	1,836	9,950	5,155	24,529	20,964	4,904	9,201	108,747	19,700	511,917	21,330
VESSELS-GASOLINE	90900630	9,222	439	33,090	1,515	41,914	107,321	62,485	906,070	138,269	31,295	1,647
DRYCLEANING	91000900	233		669	0	0	0	0	23,069	0	0	0
PESTICIDE USE	91001000	890		6,143	0	0	0	12,011	265,313	0	0	0
COMMERCIAL/CONSUMER SOLV	91002100	36,364		89,647	0	206,188	0	0	4,055,744	0	0	0
GRAPHIC ARTS	91002200	2,865		8,234	0	4,247	1,524	3,652	280,261	6,764	0	0
SMALL PROCESSES	91002300	72		248	0	895	0	201	11,556	0	0	0
GASOLINE MKTNG-OTHER	91002400	4,020		10,703	0	17,125	6,498	823	685,004	0	0	0
GASOLINE MKTNG-STAGE I	91005100	11,808		31,439	0	50,302	19,088	2,418	2,017,070	0	0	0
GASOLINE MKTNG-STAGE II	91005200	15,694		41,785	0	66,856	25,369	3,214	2,674,240	0	0	0
FOREST FIRES	91300100	1,963	263	4,839	648	0	7,115	0	159,417	11,011	11,981	2,114
AGRICULT. & MISC. BURNING	91300200	5,770	1,030	14,225	2,539	0	62,832	0	656,727	98,556	46,920	8,280
STRUCTURE FIRES	91300400	84	37	207	91	314	816	63	5,687	0	1,685	297

The minor point source data required additional evaluation. Since the data could not be processed (divided into model species by hour) by the ES programs, NYSDEC undertook the task. The SMS tracks pollutant emissions on a chemical basis. referenced to the Chemical Abstract Series (CAS) identification number. The 1980 emissions data were examined and it was determined that over 98% of the VOC emissions in the area were classified as one of 35 distinct pollutants. Factors were developed using the CBII chemical speciation for each of these 35 pollutants. The remaining 2% of VOC emissions were assigned a default speciation arrangement corresponding to that for the category Miscellaneous Organics (CAS No. NY990-00-0). The speciation breakdown for these 35 pollutants for the New York point source inventory is shown in Appendix A.

4.4.3 Mobile Sources

New York Metropolitan Transportation Council (NYMTC) provided 1980 daily mileage estimates for each of its 60 analysis areas in the New York City Metropolitan area. Mileage for each analysis area was given for five vehicle types - light duty gas vehicles (LDGV), taxis, light duty gas trucks (LDGT), heavy duty gas vehicles (HDGV), and heavy duty diesel vehicles (HDDV). For each vehicle type, mileage was given for three roadway types - freeway, arterial and local streets. Percentage hot/cold starts were also included for each roadway type by analysis area.

The assignment model that generated the above data computed the vehicle type distribution and percentage hot/cold starts on a county-wide basis. A review of these data, including comparisons of MOBILE3 emissions on the county level, revealed that each borough (county) of New York City should be modeled separately, while the suburban or surrounding counties had similar enough characteristics to use a single MOBILE3 emission simulation. Also, since taxi mileage was given for only Manhattan, Bronx, Queens and Brooklyn and taxi emissions are different from the other vehicle types, it was decided to model the taxis separately.

Table 4.4 shows the vehicle type distribution and percentage hot/cold starts used in the MOBILE3 program. The MOBILE3 version used by the NYSDEC included all USEPA suggested modifications to the model up to June 1985.

TABLE 4.4

Percentage of Hot/Cold Starts by Vehicle Type and Roadway in the New York Portion of the Modeling Domain

ROADWAY		VEHICLE TYPE DISTRIBUTION EXCLUDING FLEET TAXIS				HOT/COLD STARTS		
						NON-CAT	CATALYST	
	COUNTY	LDGV	LDGT	HDGV	HDDV	% COLD	% HOT	% COLD
FREEWAY	Manhattan	98.4%	0.8%	0.6%	0.2%	11.7%	6.0%	15.2%
	Bronx	89.3%	5.8%	3.7%	1.2%	6.5%	2.8%	8.4%
	Brooklyn	85.5%	7.7%	4.8%	2.0%	7.0%	4.2%	9.1%
	Queens	90.6%	5.0%	3.1%	1.3%	5.5%	3.1%	7.1%
	Staten Is	86.9%	7.8%	4.3%	1.0%	5.8%	3.8%	7.6%
	Other Co.	88.3%	7.8%	2.6%	1.3%	5.9%	6.4%	7.7%
ARTERIAL	Manhattan	76.0%	8.2%	10.4%	5.4%	23.5%	12.0%	30.5%
	Bronx	89.3%	5.8%	3.7%	1.2%	12.9%	5.5%	16.8%
	Brooklyn	85.5%	7.7%	4.8%	2.0%	14.0%	8.5%	18.2%
	Queens	90.6%	5.0%	3.1%	1.3%	11.0%	6.3%	14.3%
	Staten Is	86.9%	7.8%	4.3%	1.0%	11.7%	7.5%	15.2%
	Other Co	88.3%	7.8%	2.6%	1.3%	12.0%	11.0%	14.9%
LOCAL	Manhattan	76.0%	8.2%	10.4%	5.4%	44.1%	22.7%	57.4%
	Bronx	89.3%	5.8%	3.7%	1.2%	25.9%	11.1%	33.6%
	Brooklyn	85.5%	7.7%	4.8%	2.0%	30.0%	17.0%	36.3%
	Queens	90.6%	5.0%	3.1%	1.3%	22.0%	12.5%	28.5%
	Staten Is	86.9%	7.8%	4.3%	1.0%	23.3%	15.1%	30.3%
	Other Co.	88.3%	7.8%	2.6%	1.3%	23.5%	25.8%	30.6%

Typical speed scenarios were developed for rush hours, daytime, and nighttime for the three roadway categories. These are listed in Table 4.5. The data used in the analysis were obtained from the reports published by the NYS Department of Transportation which provided the hourly percentage of traffic for 15 locations within New York City as well as reports from other local agencies. The distribution of total VMT for the three roadway type categories are listed in Table 4.6.

Hourly emissions for each grid were then computed by summing for each roadway type the appropriate emission factor times the daily mileage of each analysis area within the grid, multiplied by the hourly percent of traffic and the percentage of the analysis area in the grid. The appropriate emission factor depended on the time of day (night, rush hours, in-between) and county (Manhattan, Rest of NYC) which in turn determined the speed, percentages of hot/cold start and the vehicle mix.

4.5 1980 Emissions for the Modeling Domain - Summary

The annual VOC and NO_x emissions from the three states are summarized in Table 4.7 for the four source categories. These emissions were further disaggregated as listed in Table 4.8, in g-moles on a daily basis (0400 to 2000 hours), and in terms of CBII species assuming the carbon ratios of 1,2,1.6 and 2 for Paraffins, Olefins, Carbonyls, Aromatics and Ethylenes, respectively. On a percentage basis the mobile sources contribute about 50% of the NO_x burden and approximately 45% of the VOC's for a typical day covering the hours of simulation for the base year 1980. The next important contribution to NO_x and VOC's are the area sources, with approximately 28% and 44%, respectively.

4.6 1988 Emissions Inventory

The 1988 emissions over the modeling domain were estimated based upon the control strategies proposed in the approved 1982 SIPs and projected changes in population levels. Utilizing the U.S. Census data, the area source projection

TABLE 4.5

Assumed Vehicle Speeds (MPH) by Roadway Type for New York Portion of the Modeling Domain

		ROADWAY TYPE (MPH)		
AREA	TIME	FREEWAY	ARTERIAL	LOCAL
Manhattan	Rush Hours	20	10	5
	In Between	40	30	25
	Nights	55	45	35
Rest of New York City	Rush Hours	35	25	15
	In Between	45	35	25
	Nights	55	45	35
Other Counties	Rush Hours	45	35	25
	In Between	55	45	35
	Nights	55	45	35

Rush Hours are: 7, 8, 9 AM & 3 PM to 7 PM

In Between Hrs are: 10 AM to 3 PM

Night Time Hours are: 7 PM to 7 AM

TABLE 4.6

Hourly Percentage of Total Vehicle Miles Travelled by Roadway Type for New York

HOUR	FREEWAY	ARTERIAL	LOCAL
1 AM	0.4%	0.5%	0.5%
2	0.4%	0.5%	0.5%
3	0.4%	0.5%	0.5%
4	0.6%	0.7%	0.6%
5	0.7%	1.3%	0.9%
6	2.2%	3.8%	2.8%
7	7.5%	6.6%	5.7%
8	10.1%	6.3%	6.2%
9	6.2%	5.3%	5.3%
10	5.1%	5.2%	5.5%
11	5.2%	5.4%	6.3%
12	5.4%	5.7%	6.9%
1 PM	5.4%	5.7%	6.8%
2	5.8%	6.2%	7.0%
3	6.7%	7.1%	7.4%
4	8.5%	8.3%	8.1%
5	8.9%	8.0%	7.3%
6	6.1%	6.0%	5.7%
7	4.2%	4.7%	4.7%
8	3.1%	3.7%	3.7%
9	2.4%	3.0%	2.8%
10	2.0%	2.4%	2.3%
11	1.5%	1.9%	1.8%
12	1.0%	1.2%	1.1%

TABLE 4.7

1980 Emissions Summary Over the Modeling Domain (Tons/Year)

SOURCE CATEGORY	NEW YORK		NEW JERSEY		CONNECTICUT		MODELING DOMAIN	
	VOC	NO_x	VOC	NO_x	VOC	NO_x	VOC	NO_x
MAJOR POINT SOURCES	--	61,488	957	62,349	297	26,089	1,254	149,926
MINOR POINT SOURCES	27,651	2,175	114,978	131,039	9,029	8,586	151,658	141,800
AREA SOURCES	132,883	129,390	149,288	67,716	79,002	22,551	361,173	219,657
MOBILE SOURCES	219,482	158,297	117,035	84,124	115,317	101,167	451,834	343,588
TOTAL	380,016	351,350	382,258	345,2[illegible]	203,645	158,393	965,919	854,971

TABLE 4.8

SPECIATED EMISSIONS SUMMARY FOR 1980 TYPICAL DAY (0400 TO 2000 HRS)
G-MOLES AND G-MOLES CARBON

SOURCE TYPE		NO	NO2	NOx	PAR	OLE	CARB	APO	FTH	VOC	VOC/NOx
MAJOR PT	g-moles	5,175,182	393,014	5,568,196	68,853	1,136	42,280	368	0	112,637	0.02
	% by specie	92.94%	7.06%		61.13%	1.01%	37.54%	0.33%	0.00%		
	% of TOTAL	15.87%	13.18%	15.65%	0.07%	0.04%	0.53%	0.01%	0.00%	0.10%	
MINOR PT	g-moles	2,663,471	91,041	2,754,512	9,850,952	566,199	861,614	617,787	624,259	12,515,811	4.54
	% by specie	96.69%	3.31%		78.71%	4.52%	6.88%	4.90%	4.99%		
	% of TOTAL	8.17%	3.05%	7.74%	10.54%	20.00%	10.86%	19.69%	14.81%	11.22%	
AREA	g-moles	9,078,919	754,870	9,833,789	44,929,998	445,118	2,773,712	681,070	571,640	49,401,538	5.02
	% by specie	92.32%	7.68%		90.95%	0.90%	5.61%	1.38%	1.16%		
	% of TOTAL	27.85%	25.32%	27.64%	48.09%	15.72%	34.97%	21.88%	13.56%	44.30%	
MOBILE	g-moles	15,684,255	1,742,748	17,427,003	38,577,935	1,818,341	4,253,342	1,818,341	3,020,000	49,487,959	2.84
	% by specie	90.00%	10.00%		77.95%	3.67%	8.59%	3.67%	6.10%		
	% of TOTAL	48.11%	58.45%	48.97%	41.29%	64.23%	53.63%	58.42%	71.63%	44.38%	
TOTAL	g-moles	32,601,827	2,981,673	35,583,500	93,427,738	2,830,794	7,930,948	3,112,566	4,215,899	111,517,945	3.13
	% by specie	91.62%	8.38%		83.78%	2.54%	7.11%	2.79%	3.78%		
MAJOR PT	g-moles C				68,853	2,272	42,280	2,208	0	115,613	0.02
	% by specie				59.55%	1.97%	36.57%	1.91%	0.00%		
MINOR PT	g-moles C				9,850,952	1,132,398	861,614	3,676,772	1,248,518	16,770,204	6.09
	% by specie				58.74%	6.75%	5.14%	21.92%	7.44%		
AREA	g-moles C				44,929,998	890,236	2,773,712	4,086,420	1,143,280	53,823,646	5.47
	% by specie				83.48%	1.65%	5.15%	7.59%	2.12%		
MOBILE	g-moles C				38,577,935	3,636,682	4,253,342	10,910,046	6,040,000	63,418,005	3.64
	% by specie				60.83%	5.73%	6.71%	17.20%	9.52%		
TOTAL	g-moles C				93,427,738	5,661,588	7,930,948	18,675,396	8,431,798	134,127,468	3.77
	% by specie				69.66%	4.22%	5.91%	13.92%	6.29%		

factors from 1980 to 1988 for each county were calculated and are listed in Table 4.9 for the three states. One exception to this method is the category of gasoline marketing. In the case of New York and Connecticut, the 1982 SIP regulations require the implementation of Stage II vapor recovery for 1988. Since such controls were already in place for New Jersey, they were accounted for in 1980 base year emissions for New Jersey.

4.6.1 Area Sources

Applying the factors listed in Table 4.9 to the 1980 area source inventory, projected VOC and NO_x emissions were calculated for 1988 and are listed in Tables 4.10a through 4.10d for Connecticut, New Jersey, New York, and the modeling region respectively.

4.6.2 Point Sources

The 1988 point source emissions were projected based upon control regulations expected to be in effect prior to 1988. Since the majority of the major point sources are mainly utility boilers, emission levels are not expected to change significantly from these sources. However, Connecticut expects the addition of several resource recovery facilities which will result in a slight increase in emissions under this category.

Substantial emission reductions are expected, however, from the minor point sources. Connecticut provided a 1985 inventory in the format required by the processing programs. It was considered by CTDEP to represent the emission levels expected to occur in 1988. Therefore, no projection factors were required for this data.

NJDEP utilized the 1980 emission inventory summary by SCC code and determined which source codes are subject to their control regulations and the degree of control expected. These factors were then used to project the 1980 inventory to 1988. A similar approach was adopted to project the New York minor source emissions.

TABLE 4.9

Area Source Projection Factors
From 1980 to 1988

	County Code	County	Projection Factor
Connecticut			
	0265	Fairfield	1.0374
	0425	Hartford	1.0412
	0478	Litchfield	1.0383
	0565	Middlesex	1.0711
	0705	New Haven	1.0231
	0725	New London	1.0429
	1155	Tolland	1.0616
	1505	Windham	1.0615
New Jersey			
	0300	Bergen	1.05016
	1380	Essex	0.95753
	2240	Hudson	0.97093
	2260	Hunterdon	1.11740
	2980	Mercer	1.06696
	3060	Middlesex	1.10821
	3180	Monmouth	1.06759
	3260	Morris	1.10174
	4120	Passaic	0.99778
	5020	Somerset	1.15925
	5300	Sussex	1.23865
	5440	Union	1.01167
New York			
	0600	Bronx	1.0180
	1620	Dutchess	1.0761
	3440	Kings	1.0015
	4520	Nassau	1.0119
	4660	New York	1.0177
	5140	Orange	1.1006
	5640	Putnam	1.0888
	5660	Queens	1.0127
	5720	Richmond	1.0949
	5780	Rockland	1.0682
	6580	Suffolk	1.0636
	6600	Sullivan	1.0606
	6840	Ulster	1.0517
	7320	Westchester	1.0054

TABLE 4.10a

Connecticut 1988 Area Source Emissions by SCC

DESCRIPTION	SCC	ANNUAL(tons)		DAILY (kg)		MODEL SPECIES(g-moles)						
		VOC	NOx	VOC	NOx	CARB	OLE	ARO	PAR	ETH	NO	NO2
RESIDENTIAL FUEL-ANTH.	90100111	85	38	8	4	10	10	3	169	0	78	3
RESIDENTIAL FUEL-DIST.	90100330	246	6,768	47	667	768	0	0	1,673	0	10,881	3,627
RESIDENTIAL FUEL-RESID.	90100440			0	0	0	0	0	0	0	0	0
RESIDENTIAL FUEL-NAT GAS	90100500	72	1,656	69	1,452	183	0	15	1,434	0	27,457	4,103
RESIDENTIAL FUEL-WOOD	90100600	20,318	1,402	0	0	0	0	0	0	0	0	0
COMM/INST FUEL-DIST.	90200330	20	2,081	58	3,104	944	0	0	2,057	0	66,795	675
COMM/INST FUEL-RESID.	90200440	18	1,204	46	1,796	871	0	0	1,054	0	38,646	390
COMM/INST FUEL-NAT GAS	90200500	32	905	84	2,197	225	0	18	1,765	0	46,321	1,433
INDUSTRIAL FUEL-DIST.	90300330		387	0	855	0	0	0	0	0	17,847	744
INDUSTRIAL FUEL-RESID.	90300440	1	1,882	4	4,159	72	0	0	87	0	89,050	1,356
INDUSTRIAL FUEL-NAT GAS	90300500	4	684	13	2,093	35	0	3	278	0	42,996	2,502
SURFACE COATING-ARCHITECT	90401200	7,331		27,471	0	136,438	0	33,106	1,347,012	0	0	0
SURFACE COATING-AUTO REF	90401300	2,954		10,150	0	50,411	0	12,232	497,689	0	0	0
SURFACE COATING-INDUSTRIAL	90501100	8,838		30,451	0	109,852	0	24,682	1,186,994	0	0	0
DEGREASING-COLD CLEANING	90501200			0	0	0	0	0	0	0	0	0
DEGREASING-OPEN TOP CONV	90501300	3,286		9,435	0	0	0	0	0	33,359	0	0
OFF HW VEH-GASOLINE FARM	90600700			0	0	0	0	0	0	0	0	0
OFF HW VEH-GASOLINE CONS	90600800	2,747	2,099	11,719	8,955	14,844	38,009	22,130	320,896	48,970	184,936	9,733
OFF HW SMALL ENG GASOLINE	90600900			0	0	0	0	0	0	0	0	0
OFF HW VEH-DIESEL CONST.	90700800	97	1,586	414	6,766	1,683	394	739	14,349	1,581	132,382	14,709
DIESEL RAIL LOCOMOTIVES	90702400	339	1,407	926	3,842	3,122	2,805	624	47,151	0	75,169	8,352
AIRCRAFT-MILITARY	90803100	204	69	529	170	963	241	1,035	25,011	756	3,587	111
AIRCRAFT-CIVIL	90803200	121	4	220	7	400	100	430	10,386	314	146	5
AIRCRAFT-COMMERCIAL	90803300	554	487	1,438	1,201	2,614	655	2,810	67,923	2,054	25,317	783
VESSELS-RESIDUAL	90900440		19	0	47	0	0	0	0	0	998	20
VESSELS-DIESEL	90904230	81	445	227	1,097	925	216	406	7,886	869	22,895	954
VESSELS-GASOLINE	90904430	4,113	102	14,758	352	18,694	47,865	27,868	404,106	61,668	7,271	383
CUTBACK ASPHALT	91000600	1,556		7,121	0	0	0	0	465,586	0	0	0
DRYCLEANING	91000800	2,868		8,235	0	0	0	0	283,954	0	0	0
PESTICIDE USE	91000900			0	0	0	0	0	0	0	0	0
COMMERCIAL/CONSUMER SOLV	91002100	9,962		24,559	0	56,486	0	0	1,111,080	0	0	0
GRAPHIC ARTS	91002200	1,875		5,389	0	2,780	997	2,390	183,417	4,427	0	0
SMALL PROCESSES	91002300	1,713		5,902	0	21,292	0	4,784	274,925	0	0	0
GASOLINE MKTNG-OTHER	91002400	7,376		19,638	0	31,422	11,923	1,511	1,256,862	0	0	0
GASOLINE MKTNG-STAGE I	91005100)	-		0	0	0	0	0	0	0	0	0
GASOLINE MKTNG-STAGE II	91005200)	-		0	0	0	0	0	0	0	0	0
STRUCTURE FIRES	91300600	211	21	520	52	788	2,050	158	14,273	0	957	169
CONNECTICUT TOTALS		77,022	23,246	179,432	38,814	455,819	105,267	134,942	7,528,019	153,998	793,728	50,052

TABLE 4.10b

New Jersey 1988 Area Source Emissions by SCC

DESCRIPTION	SCC	ANNUAL(tons) VOC	ANNUAL(tons) NOx	DAILY (kg) VOC	DAILY (kg) NOx	MODEL SPECIES(g-mol-s) CARB	OLE	ARO	PAR	ETH	NO	NO2
RESIDENTIAL FUEL-ANTH.	90100111	60	72	6	7	7	7	2	119	0	148	6
RESIDENTIAL FUEL-DIST.	90100330	463	8,666	89	855	1,445	0	0	3,149	0	13,933	4,644
RESIDENTIAL FUEL-RESID.	90100440	7	1,124	1	111	22	0	0	27	0	2,385	24
RESIDENTIAL FUEL-NAT GAS	90100500	240	4,843	229	4,246	610	0	50	4,782	0	80,297	11,998
RESIDENTIAL FUEL-WOOD	90100600	2	0	0	0	0	0	0	0	0	0	0
COMM/INST FUEL-DIST.	90200330	112	2,588	326	4,009	5,286	0	0	11,520	0	86,278	871
COMM/INST FUEL-RESID.	90200440	128	8,461	329	12,619	6,193	0	0	7,498	0	271,578	2,743
COMM/INST FUEL-NAT GAS	90200500	90	1,957	237	4,750	633	0	52	4,965	0	100,166	3,098
INDUSTRIAL FUEL-DIST.	90300330	54	1,519	233	3,357	3,776	0	0	8,229	0	70,050	2,919
INDUSTRIAL FUEL-RESID.	90300440	55	4,439	210	9,809	3,943	0	0	4,774	0	210,038	3,199
INDUSTRIAL FUEL-NAT GAS	90300500	24	2,060	80	6,303	213	0	17	1,669	0	129,492	7,537
SURFACE COATING-ARCHITECT	90401200	12,455	0	46,671	0	231,801	0	56,245	2,288,505	0	0	0
SURFACE COATING-AUTO REF	90401300	4,872	0	16,740	0	83,142	0	20,174	820,833	0	0	0
DEGREASING-COLD CLEANING	90501200	3,844	0	11,037	0	57,024	0	8,914	382,108	4,730	0	0
DEGREASING-OPEN TOP CONV	90501300	3,844	0	11,037	0	0	0	0	0	39,024	0	0
OFF HW VEH-GASOLINE FARM	90600700	0	0	0	0	0	0	0	0	0	0	0
OFF HW VEH-GASOLINE CONS	90600800	809	592	3,451	2,526	4,372	11,194	6,517	94,505	14,422	52,159	2,745
OFF HW SMALL ENG GASOLINE	90600900	1,013	609	4,546	2,733	5,758	14,743	8,584	124,470	18,995	56,438	2,970
OFF HW VEH-DIESEL CONST.	90700800	1,688	24,037	7,201	102,547	29,286	6,851	12,853	249,697	27,520	2,006,354	222,928
DIESEL RAIL LOCOMOTIVES	90702400	1,020	4,118	2,785	11,245	9,394	8,440	1,878	141,870	0	220,004	24,445
AIRCRAFT-MILITARY	90703100	31	1	80	2	146	37	157	3,801	115	52	2
AIRCRAFT-CIVIL	90703200	164	40	298	69	542	136	582	14,077	626	1,456	45
AIRCRAFT-COMMERCIAL	90703300	2,857	2,105	7,414	5,189	13,480	3,380	14,492	350,203	10,591	109,428	3,384
VESSELS-RESIDUAL	90700440	12	194	51	478	960	0	0	1,162	0	10,189	208
VESSELS-DIESEL	90704230	60	502	168	1,238	685	160	301	5,841	644	25,827	1,076
VESSELS-GASOLINE	90704430	290	449	1,041	1,550	1,318	3,375	1,965	28,493	4,348	32,008	1,685
CUTBACK ASPHALT	91000600	2,000	0	9,153	0	0	0	0	598,440	0	0	0
DRYCLEANING	91000800	2,923	0	8,393	0	0	0	0	289,400	0	0	0
PESTICIDE USE	91000900	637	0	4,397	0	0	0	8,596	189,893	0	0	0
COMMERCIAL/CONSUMER SOLV	91002100	16,162	0	39,844	0	91,640	0	0	1,807,578	0	0	0
GRAPHIC ARTS	91002200	2,040	0	5,863	0	3,024	1,085	2,600	199,558	4,816	0	0
SMALL PROCESSES	91002300	70,432	0	242,671	0	875,438	0	196,694	11,303,852	0	0	0
GASOLINE MKTNG-OTHER	91002600	0	0	0	0	0	0	0	0	0	0	0
GASOLINE MKTNG-STAGE I	91005100	343	0	913	0	1,461	554	70	58,447	0	0	0
GASOLINE MKTNG-STAGE II	91005200	1,817	0	4,838	0	7,740	2,937	372	309,615	0	0	0
STRUCTURE FIRES	91108400	7,433	1,469	18,324	3,621	27,764	72,227	5,551	507,796	0	66,918	11,809
NEW JERSEY TOTALS		137,981	69,945	448,657	177,263	1,467,103	175,126	346,669	19,806,953	175,630	3,545,201	308,337

TABLE 4.10c

New York 1988 Area Source Emissions by SCC

DESCRIPTION	SCC	ANNUAL(tons)		DAILY (kg)		MODEL SPECIES(g-moles)						
		VOC	NOx	VOC	NOx	CARB	OLE	ARO	PAR	ETH	NO	NO2
RESIDENTIAL FUEL-ANTH.	90100111	63	244	6	24	7	7	2	125	0	502	21
RESIDENTIAL FUEL-DIST.	90100330	917	17,093	176	1,686	2,861	0	0	6,236	0	27,482	9,161
RESIDENTIAL FUEL-RESID.	90100440	187	10,243	32	1,010	598	0	0	724	0	21,738	220
RESIDENTIAL FUEL-NAT GAS	90100500		9,628	0	8,440	0	0	0	0	0	159,633	23,853
RESIDENTIAL FUEL-WOOD	90100600	2,427	459	0	0	0	0	0	0	0	0	0
COMM/INST FUEL-BITUM.	90200222	36	151	4	19	5	5	2	90	0	392	16
COMM/INST FUEL-DIST.	90200330	155	4,045	451	6,033	7,315	0	0	15,943	0	129,815	1,311
COMM/INST FUEL-RESID.	90200440	228	12,648	586	18,863	11,032	0	0	13,356	0	405,971	4,101
COMM/INST FUEL-NAT GAS	90200500	37	1,669	98	4,051	260	0	21	2,041	0	85,425	2,642
INDUSTRIAL FUEL-DIST.	90300330	117	2,951	504	6,521	8,181	0	0	17,830	0	136,087	5,670
INDUSTRIAL FUEL-RESID.	90300440	48	3,647	183	8,059	3,441	0	0	4,166	0	172,564	2,628
INDUSTRIAL FUEL-NAT GAS	90300500	5	1,980	17	6,059	44	0	4	348	0	124,463	7,244
ON-SITE INCINERATION	90401100	24	34	75	107	114	297	23	2,069	0	0	0
SURFACE COATING-ARCHITECT	90401200	17,818		66,768	0	331,612	0	80,463	3,273,913	0	0	0
SURFACE COATING-AUTO REF	90401300	6,854		23,550	0	116,965	0	28,381	1,154,760	0	0	0
DEGREASING-COLD CLEANING	90501200	4,712		11,529	0	69,901	0	10,927	468,391	5,798	0	0
DEGREASING-OPEN TOP CONV	90501300			0	0	0	0	0	0	0	0	0
OFF HW VEH-GASOLINE FARM	90600700	879	338	2,045	786	2,590	6,631	3,861	55,984	8,543	16,237	855
OFF HW VEH-GASOLINE CONS	90600800	1,430	1,772	6,101	7,560	7,728	19,786	11,520	167,048	25,492	156,125	8,217
OFF HW SMALL ENG GASOLINE	90600900			0	0	0	0	0	0	0	0	0
OFF HW VEH-DIESEL FARM	90700700	558	6,129	1,298	14,256	5,278	1,235	2,316	45,003	4,960	278,974	30,992
OFF HW VEH-DIESEL CONST.	90700800	912	33,883	3,891	144,552	15,823	3,701	6,944	134,907	14,868	2,828,194	314,244
INDUSTRIAL EQUIP. - DIESEL	90702200	112	1,441	326	4,190	1,324	310	581	11,291	1,244	81,973	9,108
DIESEL RAIL LOCOMOTIVES	90702400	620	2,868	1,693	7,831	5,710	5,130	1,141	86,234	0	153,273	17,025
AIRCRAFT-MILITARY	90801100	1,777	1,401	4,611	3,454	8,384	2,102	9,014	217,869	6,588	72,811	2,252
AIRCRAFT-CIVIL	90801200	1,687	290	3,065	501	5,572	1,397	5,991	144,803	4,378	10,554	326
AIRCRAFT-COMMERCIAL	90801300	1,367	5,694	3,547	14,037	6,450	1,617	6,934	167,601	5,068	296,002	9,155
VESSELS-RESIDUAL	90900440	49	1,854	208	4,571	3,919	0	0	4,745	0	97,374	1,987
VESSELS-DIESEL	90905230	1,932	10,477	5,425	25,829	22,060	5,161	9,682	188,093	20,730	539,031	22,460
VESSELS-GASOLINE	90905430	9,617	439	34,507	1,515	43,709	111,918	65,161	944,879	144,192	31,295	1,647
DRYCLEANING	91000800	233		669	0	0	0	0	23,069	0	0	0
PESTICIDE USE	91000900	899		6,206	0	0	0	12,132	267,996	0	0	0
COMMERCIAL/CONSUMER SOLV	91002100	37,257		91,848	0	211,251	0	0	4,155,342	0	0	0
GRAPHIC ARTS	91002200	2,916		8,381	0	4,323	1,551	3,717	285,250	6,884	0	0
SMALL PROCESSES	91002300	72		248	0	895	0	201	11,556	0	0	0
GASOLINE MKTNG-OTHER	91002600	2,734		7,279	0	11,647	4,420	560	465,871	0	0	0
GASOLINE MKTNG-STAGE I	91005100	8,230		21,912	0	35,060	13,304	1,686	1,402,383	0	0	0
GASOLINE MKTNG-STAGE II	91005200	10,956		29,170	0	46,672	17,710	2,244	1,866,890	0	0	0
FOREST FIRES	91300100	2,095	267	5,165	658	0	7,594	0	170,132	35,211	12,163	2,146
AGRICULT. & MISC. BURNING	91300200	6,011	1,040	14,819	2,564	0	65,456	0	684,152	102,672	47,376	8,360
STRUCTURE FIRES	91300400	84	37	207	91	314	816	63	5,682	0	1,685	297
NEW YORK TOTALS		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE 4.10d

1988 Area Source Emissions by SCC in the Modeling Domain

DESCRIPTION	SCC	ANNUAL(tons)		DAILY (kg)		MODEL SPECIES(g-moles)						
		VOC	NOx	VOC	NOx	CARB	OLE	ARO	PAR	ETH	NO	NO2
RESIDENTIAL FUEL-ANTH.	90100111	208	354	21	35	25	25	8	413	0	779	30
RESIDENTIAL FUEL-DIST.	90100330	1,626	32,577	313	3,208	5,074	0	0	11,058	0	52,296	17,432
RESIDENTIAL FUEL-RESID.	90100440	194	11,367	33	1,121	621	0	0	751	0	24,124	244
RESIDENTIAL FUEL-NAT GAS	90100500	312	16,177	297	14,138	793	0	65	6,216	0	267,387	39,954
RESIDENTIAL FUEL-WOOD	90100600	22,747	1,861	0	0	0	0	0	0	0	0	0
COMM/INST FUEL-BITUM.	90200222	36	151	4	19	5	5	2	90	0	392	16
COMM/INST FUEL-DIST.	90200330	287	8,814	834	13,145	13,545	0	0	29,520	0	282,908	2,858
COMM/INST FUEL-RESID.	90200440	374	22,313	962	33,278	18,096	0	0	21,908	0	716,194	7,234
COMM/INST FUEL-NAT GAS	90200500	159	4,511	419	10,998	1,119	0	91	8,771	0	231,913	7,173
INDUSTRIAL FUEL-DIST.	90300330	171	4,857	737	10,733	11,957	0	0	26,059	0	223,984	9,333
INDUSTRIAL FUEL-RESID.	90300440	104	9,968	396	22,026	7,456	0	0	9,026	0	471,652	7,183
INDUSTRIAL FUEL-NAT GAS	90300500	33	4,774	110	14,455	293	0	24	2,295	0	296,952	17,283
ON-SITE INCINERATION	90401100	24	14	75	107	114	297	23	2,069	0	0	0
SURFACE COATING-ARCHITECT	90401200	37,604	0	140,910	0	699,851	0	169,814	6,909,430	0	0	0
SURFACE COATING-AUTO REF	90401300	14,680	0	50,440	0	250,517	0	60,786	2,473,283	0	0	0
SURFACE COATING-INDUSTRIAL	90501100	8,838	0	30,451	0	109,852	0	24,682	1,186,974	0	0	0
DEGREASING-COLD CLEANING	90501200	8,556	0	24,566	0	126,925	0	19,842	850,499	10,528	0	0
DEGREASING-OPEN TOP CONV	90501300	7,130	0	20,472	0	0	0	0	0	72,383	0	0
OFF HW VEH-GASOLINE FARM	90600700	879	318	2,045	786	2,590	6,631	3,861	55,984	8,543	16,237	855
OFF HW VEH-GASOLINE CONS	90600800	4,986	4,463	21,271	19,040	26,944	68,989	40,167	582,449	88,884	393,220	20,696
OFF HW SMALL ENG GASOLINE	90600900	1,013	609	4,546	2,733	5,758	14,743	8,584	174,470	18,995	56,438	2,970
OFF HW VEH-DIESEL FARM	90700700	558	6,129	1,298	14,256	5,278	1,235	2,316	45,003	4,960	278,924	30,992
OFF HW VEH-DIESEL CONST.	90700800	2,697	59,506	11,506	253,865	46,791	10,946	20,535	398,952	43,969	4,966,930	551,881
INDUSTRIAL EQUIP. - DIESEL	90702200	112	1,441	326	4,190	1,324	310	581	11,291	1,244	81,973	9,108
DIESEL RAIL LOCOMOTIVES	90702400	1,979	8,393	5,404	22,918	18,226	16,375	3,643	275,255	0	448,396	49,822
AIRCRAFT-MILITARY	90803100	2,012	1,471	5,221	3,626	9,493	2,380	10,206	246,682	7,459	76,470	2,365
AIRCRAFT-CIVIL	90803200	1,972	334	3,583	576	6,514	1,633	7,003	169,266	5,118	12,156	376
AIRCRAFT-COMMERCIAL	90803300	4,778	8,286	12,399	20,427	22,544	5,652	24,237	585,807	17,713	430,747	13,322
VESSELS-RESIDUAL	90900440	61	2,067	259	5,096	4,879	0	0	5,907	0	108,560	2,216
VESSELS-DIESEL	90904230	2,073	11,424	5,821	28,163	23,670	5,537	10,388	201,870	22,243	587,751	24,490
VESSELS-GASOLINE	90904430	14,020	990	50,306	3,417	63,721	163,158	94,994	1,377,477	210,208	70,575	3,714
CUTBACK ASPHALT	91000600	3,556	0	16,275	0	0	0	0	1,064,026	0	0	0
DRYCLEANING	91000800	6,024	0	17,296	0	0	0	0	596,423	0	0	0
PESTICIDE USE	91000900	1,536	0	10,603	0	0	0	20,728	457,889	0	0	0
COMMERCIAL/CONSUMER SOLV	91002100	63,381	0	156,251	0	359,377	0	0	7,068,979	0	0	0
GRAPHIC ARTS	91002200	6,831	0	19,633	0	10,127	3,633	8,708	668,224	16,127	0	0
SMALL PROCESSES	91002300	72,217	0	248,821	0	897,624	0	201,679	11,590,333	0	0	0
GASOLINE MKTNG-OTHER	91002600	10,110	0	26,918	0	43,068	16,343	2,071	1,772,733	0	0	0
GASOLINE MKTNG-STAGE I	91005100	8,573	0	22,825	0	36,521	13,858	1,756	1,460,830	0	0	0
GASOLINE MKTNG-STAGE II	91005200	12,773	0	34,008	0	54,413	20,648	2,616	2,176,505	0	0	0
FOREST FIRES	91308100	2,095	267	5,165	658	0	7,594	0	170,132	35,231	12,163	2,146
AGRICULT. & MISC. BURNING	91308200	6,011	1,040	14,819	2,564	0	65,456	0	684,152	102,672	47,376	8,360
STRUCTURE FIRES	91308400	7,728	1,527	19,052	3,764	28,866	75,094	5,773	572,751	0	69,561	12,275

4.6.3 Mobile Sources

New Jersey and Connecticut provided 1988 mobile emissions determined by using MOBILE3 with updated VMT (vehicle miles travelled) data and emission factors. New York's 1982 SIP assumed a 2% annual growth rate to project future years' mileage. The actual annual growth rate through 1985 by county, listed in Table 4.11, was 2.2% which was adopted to project the 1988 levels.

In summary, the projected 1988 annual emissions for VOC and NO_x by source type and region are listed in Table 4.12a and in Table 4.12b, along with the speciated emissions summary for the model application. The percentage change from the 1980 base year (see Table 4.12a) shows that there is an overall reduction of about 32% and 14% in the VOC's and NO_x emissions, respectively.

4.7 1988 Emissions Inventory Including Extraordinary Measures

The 1988 projection inventory included only those control strategies that are implemented to date. Other SIP mandated measures such as Stage II gasoline vapor recovery, controls on architectural surface coating, automobile refinishing and consumer/commercial solvent and small source RACT have not been fully implemented. Thus, each of these measures are assessed separately and collectively. In Table 4.13a are listed the emission summaries by state and source type with the imposition of Stage II controls which has effectively achieved another 2% reduction in the VOC emissions. Adoption of the other control measures noted earlier would result in a further reduction of about 6% in the VOC emissions (see Table 4.13b) or a total reduction of 40% from the 1980 base year.

TABLE 4.11

Projected Annual Growth Rate in Vehicle Miles For New York Portion of the Modeling Domain from 1980 to 1988

			ANNUAL	
COUNTY	1980-1985 INCR	GROWTH RATE	1980-1988 INCR	GROWTH RATE
Manhattan	10.7%	2.1%	17.7%	2.1%
Bronx	8.3%	1.6%	13.6%	1.6%
Brooklyn	9.4%	1.8%	15.5%	1.8%
Queens	10.8%	2.1%	17.8%	2.1%
Staten Is	19.5%	3.6%	33.0%	3.6%
Nassau	8.5%	1.6%	23.9%	1.6%
Suffolk	15.9%	3.0%	26.6%	3.0%
Westch.	10.5%	2.0%	17.3%	2.0%
Rockland	12.5%	2.4%	20.7%	2.4%
Putnam	21.6%	4.0%	36.7%	4.0%
Dutchess	16.9%	3.2%	28.4%	3.2%
Orange	12.2%	2.3%	20.2%	2.3%

	80-88 INCR	GROWTH RATE
NEW YORK CITY	18.6%	2.2%
OTHER COUNTIES	19.7%	2.3%
COMBINED	19.3%	2.2%

TABLE 4.12b

SPECIATED EMISSIONS SUMMARY FOR 1988 TYPICAL DAY (0600 TO 2000 HRS)

G-MOLES AND G-MOLES CARBON

SOURCE TYPE		NO	NO2	NOx	PAR	OLE	CARB	ARO	ETH	VOC	VOC/NOx
MAJOR PT	g-moles	5,398,898	419,890	5,818,788	87,393	4,624	38,756	656	0	131,429	0.02
	% by specie	92.78%	7.22%		66.49%	3.52%	29.49%	0.50%	0.00%		
	% of TOTAL	19.47%	17.63%	19.33%	0.14%	0.27%	0.73%	0.03%	0.00%	0.18%	
	% change from 1980	4.3%	6.8%	4.5%	26.9%	307.0%	-8.3%	78.3%	NA	16.7%	
MINOR PT	g-moles	3,122,126	88,163	3,210,289	5,779,210	346,394	566,566	324,334	391,897	7,408,401	2.31
	% by specie	97.25%	2.75%		78.01%	4.68%	7.65%	4.38%	5.29%		
	% of TOTAL	11.26%	3.70%	10.66%	9.36%	19.98%	10.66%	16.62%	14.23%	10.08%	
	% change from 1980	17.2%	-3.2%	16.5%	-41.3%	-38.8%	-34.2%	-47.1%	-37.2%	-40.8%	
AREA	g-moles	8,949,727	733,730	9,683,457	39,202,523	422,686	2,622,301	666,327	592,912	43,506,749	4.49
	% by specie	92.42%	7.58%		90.11%	0.97%	6.03%	1.53%	1.36%		
	% of TOTAL	32.28%	30.81%	32.16%	63.53%	24.38%	49.34%	34.15%	21.53%	59.22%	
	% change from 1980	-1.4%	-2.8%	-1.5%	-12.7%	-5.0%	-5.5%	-2.2%	3.7%	-11.9%	
MOBILE	g-moles	10,253,727	1,139,370	11,393,097	16,642,603	959,955	2,086,819	959,955	1,768,619	22,417,951	1.97
	% by specie	90.00%	10.00%		74.24%	4.28%	9.31%	4.28%	7.89%		
	% of TOTAL	36.98%	47.85%	37.84%	26.97%	55.37%	39.27%	49.20%	64.23%	30.52%	
	% change from 1980	-34.6%	-34.6%	-34.6%	-56.9%	-47.2%	-50.9%	-47.2%	-61.4%	-54.7%	
TOTAL	g-moles	27,724,478	2,381,153	30,105,631	61,711,729	1,733,659	5,314,442	1,951,272	2,753,428	73,464,530	2.44
	% by specie	92.09%	7.91%		84.00%	2.36%	7.23%	2.66%	3.75%		
	% change from 1980	-15.0%	-20.1%	-15.4%	-33.9%	-38.8%	-33.0%	-37.3%	-34.7%	-34.1%	
MAJOR PT	g-moles C				87,393	9,248	38,756	3,936	0	139,333	0.02
	% by specie				62.72%	6.64%	27.82%	2.82%	0.00%		
MINOR PT	g-moles C				5,779,210	692,788	566,566	1,946,004	783,794	9,768,362	3.04
	% by specie				59.16%	7.09%	5.80%	19.92%	8.02%		
AREA	g-moles C				39,202,523	845,372	2,622,301	3,997,962	1,185,824	47,853,982	4.94
	% by specie				81.92%	1.77%	5.48%	8.35%	2.48%		
MOBILE	g-moles C				16,642,603	1,919,910	2,086,819	5,759,730	3,537,238	29,946,300	2.63
	% by specie				55.57%	6.41%	6.97%	19.23%	11.81%		
TOTAL	g-moles C				61,711,729	3,467,318	5,314,442	11,707,632	5,506,856	87,707,977	2.91

TABLE 4.12a

Projected 1988 Emissions Summary Over the Modeling Domain (Tons/Year)

SOURCE TYPE	NEW YORK		NEW JERSEY		CONNECTICUT		TOTAL AREA	
	VOC	NO_x	VOC	NO_x	VOC	NO_x	VOC	NO_x
MAJOR POINT SOURCES	-	61,488	957	62,349	850	29,141	1,807	152,978
% CHANGE FROM 1980	0.0	0.0	0.0	0.0	186.2	11.7	44.1	2.0
MINOR POINT SOURCES	13,167	2,175	69,444	128,446	7,223	5,104	89,834	135,725
% CHANGE FROM 1980	-52.4	0.0	-39.6	-2.0	-20.0	-40.6	-40.8	-4.3
AREA SOURCES	126,055	132,722	137,981	69,945	77,022	23,246	341,058	225,913
% CHANGE FROM 1980	-5.1	2.6	-7.6	3.3	-2.5	3.1	-5.6	2.8
MOBILE SOURCES	101,971	95,764	64,420	63,559	55,196	64,878	221,587	224,241
% CHANGE FROM 1980	-53.5	-39.5	-45.0	-24.4	-52.1	-35.9	-51.0	-34.7
TOTAL	241,193	292,149	272,802	324,339	140,291	122,369	654,286	738,857
% CHANGE FROM 1980	-36.5	-16.8	-28.6	-6.1	-31.1	-22.7	-32.3	-13.6

TABLE 4.13a

Projected 1988 Emissions Summary with Stage II Controls (Tons/Year)

SOURCE TYPE	NEW YORK		NEW JERSEY		CONNECTICUT		MODELING DOMAIN	
	VOC	NO_x	VOC	NO_x	VOC	NO_x	VOC	NO_x
MAJOR POINT SOURCES	-	61,488	957	62,349	850	29,141	1,807	152,978
% CHANGE FROM 1980	0.0	0.0	0.0	0.0	186.2	11.7	44.1	2.0
MINOR POINT SOURCES	13,167	2,175	69,444	128,446	7,223	5,104	89,834	135,725
% CHANGE FROM 1980	-52.4	0.0	-39.6	-2.0	-20.0	-40.6	-40.8	-4.3
AREA SOURCES	111,441	132,722	137,981	69,945	70,744	23,246	320,166	225,913
% CHANGE FROM 1980	-16.1	2.6	-7.6	3.3	-10.5	3.1	-11.4	2.8
MOBILE SOURCES	101,971	95,764	64,420	63,599	55,196	64,878	221,587	224,241
% CHANGE FROM 1980	-53.5	-39.5	-45.0	-24.4	-52.1	-35.9	-51.0	-34.7
TOTAL	226,579	292,149	272,802	324,339	134,013	122,369	633,394	738,857
% CHANGE FROM 1980	-40.4	-16.8	-28.6	-6.1	-34.2	-22.7	-34.4	-13.6

TABLE 4.13b

Projected 1988 Emissions Summary with Full SIP (Tons/Year)

SOURCE TYPE	NEW YORK		NEW JERSEY		CONNECTICUT		MODELING DOMAIN	
	VOC	NO_x	VOC	NO_x	VOC	NO_x	VOC	NO_x
MAJOR POINT SOURCES	-	61,488	957	62,349	850	29,141	1,807	152,978
% CHANGE FROM 1980	0.0	0.0	0.0	0.0	186.2	11.7	44.1	2.0
MINOR POINT SOURCES	13,167	2,175	69,444	128,446	7,223	5,104	89,834	135,725
% CHANGE FROM 1980	-52.4	0.0	-39.6	-2.0	-20.0	-40.6	-40.8	-4.3
AREA SOURCES	84,025	132,722	120.959	69,945	60,437	23.246	265,421	225,913
% CHANGE FROM 1980	-36.8	2.6	-19.0	3.3	-23.5	3.1	-26.5	2.8
MOBILE SOURCES	101,971	95,764	64,420	63,599	55,196	64,878	221,587	224,241
% CHANGE FROM 1980	-53.5	-39.5	-45.0	-24.4	-52.1	-35.9	-51.0	-34.7
TOTAL	199,163	292,149	255,780	324,339	123,706	122,369	578,649	738,857
% CHANGE FROM 1980	-47.6	-16.8	-33.1	-6.1	-39.3	-22.7	-40.1	-13.6

CHAPTER 5

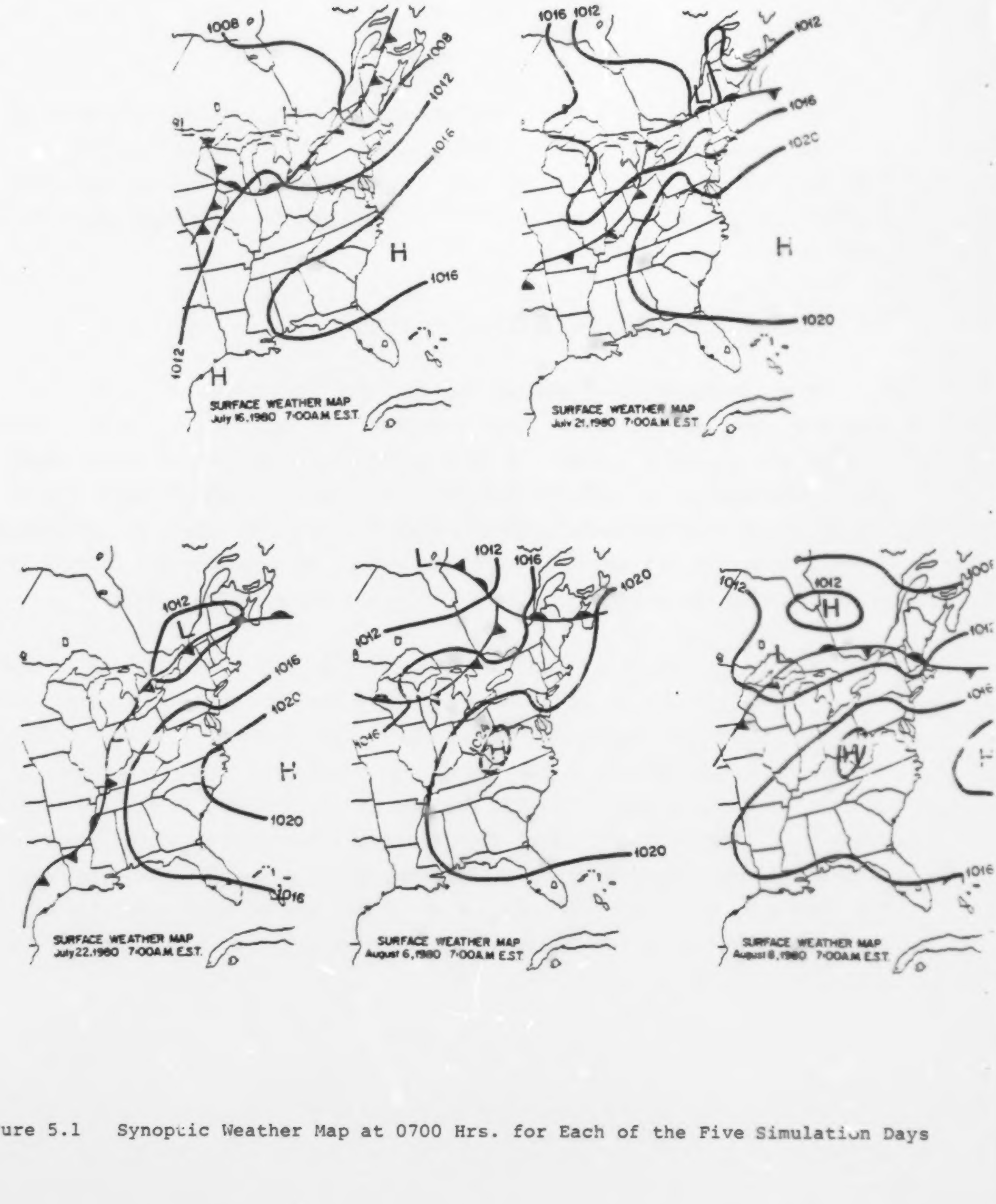
MODEL APPLICATION

For each of the five days selected, a simulation package conforming to the UAM input requirements (USEPA; 1985a, 1985b) was prepared for the 16 hour simulation period (0400 to 2000 Hrs) using the methodologies described in Chapter 3. The detailed descriptions of the input data for each day are given below.

5.1 Input Data for JD80198(071680) Simulation

On the synoptic scale weather map for this day, shown in Figure 5.1a, the "Bermuda" type high pressure area extended from the Atlantic Ocean westward through the southern states. A cold front lay from the Canadian Maritimes west-southwestward to western Lake Erie, where it became a warm front; the latter turned west-northwestward into western Wisconsin, where an occluded-cold frontal structure ran nearly north-south. Weak low pressure was located to the west of the Lakes, while weak high pressure was found to their east.

The hourly vector-averaged wind speeds and directions for this day are listed in Table 5.1. The winds were generally from the south-southwest around 4 to 5 m/s. The other meteorological parameters are listed in Tables 5.2 and 5.3. The mixing height reached a maximum of 1460 m. The pollutant gradients in the vertical and the concentrations at the top of the modeling region are listed in Table 5.4. The initial surface distributions of the pollutants are shown in Figure 5.2. The hourly highest and second highest measured ozone concentrations are listed in Table 5.5. A peak value of 291 ppb occurred over Connecticut. The diurnal variation of the pollutant concentrations in the southwest corner cell are displayed in Figure 5.3.


1008
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SURFACE WEATHER MAP
July 16, 1980 7:00 A.M. E.S.T.
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SURFACE WEATHER MAP
July 21, 1980 7:00 A.M. E.S.T.
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SURFACE WEATHER MAP
July 22, 1980 7:00 A.M. E.S.T.
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SURFACE WEATHER MAP
August 6, 1980 7:00 A.M. E.S.T.
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SURFACE WEATHER MAP
August 8, 1980 7:00 A.M. E.S.T.

Figure 5.1 Synoptic Weather Map at 0700 Hrs. for Each of the Five Simulation Days

TABLE 5.1

Vector-Averaged Hourly Winds for JD80198(071680) Simulation

HOUR	WIND SPEED (m/s)	WIND DIRECTION (°)
0400 - 0500	3.93	230
0500 - 0600	4.63	225
0600 - 0700	3.79	225
0700 - 0800	4.07	227
0800 - 0900	4.40	231
0900 - 1000	4.69	232
1000 - 1100	4.72	230
1100 - 1200	4.71	225
1200 - 1300	4.24	231
1300 - 1400	4.75	234
1400 - 1500	4.76	239
1500 - 1600	5.30	232
1600 - 1700	4.88	246
1700 - 1800	5.17	232
1800 - 1900	4.51	219
1900 - 2000	4.23	200

TABLE 5.2

Hourly Diffusion Break (Mixing Height), Region and Vertical Cell Top Heights for JD80198(071680) Simulation

HOUR	DIFFUSION BREAK (m)	REGION TOP (m)	TOP OF CELL (m) 3	2	1
0400 - 0500	450	1000	450	300	150
0500 - 0600	450	1000	450	300	150
0600 - 0700	450	1000	450	300	150
0700 - 0800	450	1000	450	300	150
0800 - 0900	450	1000	450	300	150
0900 - 1000	525	1025	525	350	175
1000 - 1100	630	1100	600	400	200
1100 - 1200	765	1205	705	470	235
1200 - 1300	1145	1295	795	530	265
1300 - 1400	1400	1400	900	600	300
1400 - 1500	1460	1460	960	640	320
1500 - 1600	1460	1460	960	640	320
1600 - 1700	1460	1460	960	640	320
1700 - 1800	1250	1460	900	600	300
1800 - 1900	1060	1460	855	570	285
1900 - 2000	900	1460	795	530	265

TABLE 5.3

Metscalar Input Parameters for JD80198(071680) Simulation

HOUR	TEMPERATURE GRADIENT (°K/m)		EXPOSURE INDEX	PHOTOLYSIS RATE	CONCENTRATION OF WATER VAPOR (PPM)	ATMOSPHERIC PRESSURE (ATM)
	BELOW	ABOVE				
0400-0500	.0014	-.0049	0	.0010	13535.0	0.9778
0500-0600	.0014	-.0049	0	.0010	13535.0	0.9778
0600-0700	.0014	-.0049	1	.0063	13535.0	0.9777
0700-0800	-.0008	-.0050	1	.1302	15064.0	0.9772
0800-0900	-.0031	-.0052	1	.2774	15069.0	0.9771
0900-1000	-.0053	-.0053	2	.3770	15549.0	0.9769
1000-1100	-.0075	-.0055	2	.4445	16136.0	0.9766
1100-1200	-.0098	-.0057	2	.4867	16647.0	0.9765
1200-1300	-.0098	-.0058	2	.5146	16647.0	0.9764
1300-1400	-.0098	-.0059	1	.5372	16652.0	0.9760
1400-1500	-.0098	-.0061	1	.5407	16664.0	0.9752
1500-1600	-.0074	-.0062	1	.5254	16676.0	0.9747
1600-1700	-.0051	-.0064	1	.4910	16681.0	0.9742
1700-1800	-.0027	-.0065	1	.3274	16696.0	0.9744
1800-1900	-.0004	-.0065	0	.1669	16696.0	0.9744
1900-2000	-.0004	-.0065	0	.0183	17322.0	0.9742

TABLE 5.4

Pollutant Gradients in the Vertical and Concentrations at the Top of the Modeling Region for JD80198(071680)

Pollutant	Gradient (ppb/100m)	Concentration at the Top of the Modeling Region (ppb)
O_3	5.62	85
NO_2	-4.19	4
NMHC*	-34.66	30
CO	-50.00	20

*ppbc/100 m

Table 5.5

Hourly Highest and Second Highest Ozone Concentrations Measured on JD80198(071680)

HOUR	HIGHEST CONCENTRATION (ppb)	STATION	2nd HIGHEST CONCENTRATION (ppb)	STATION
1200 - 1300	210	New Haven	183	Greenwich
1300 - 1400	280*	Stratford	252	Derby
1400 - 1500	291**	New Haven	291*	Derby
1500 - 1600	274	Stratford	260	Hartford
1600 - 1700	265	Hartford	262	Middletown
1700 - 1800	230	Middletown	170	Hartford
1800 - 1900	157	Middletown	117	Stratford

* Highest for the day

** Second highest for the day

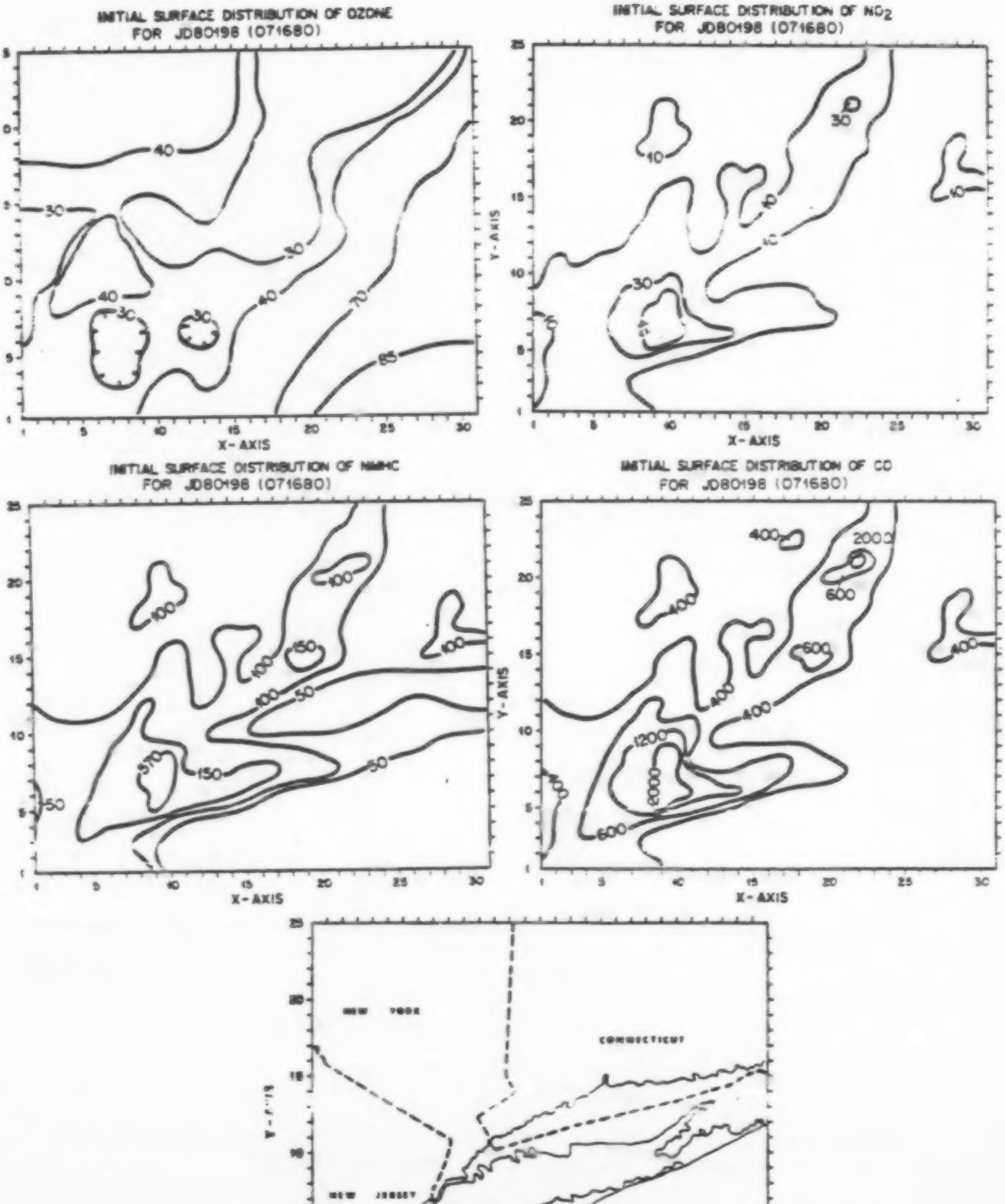


Figure 5.2 Initial Pollutant Distribution on JD80198 (071680)

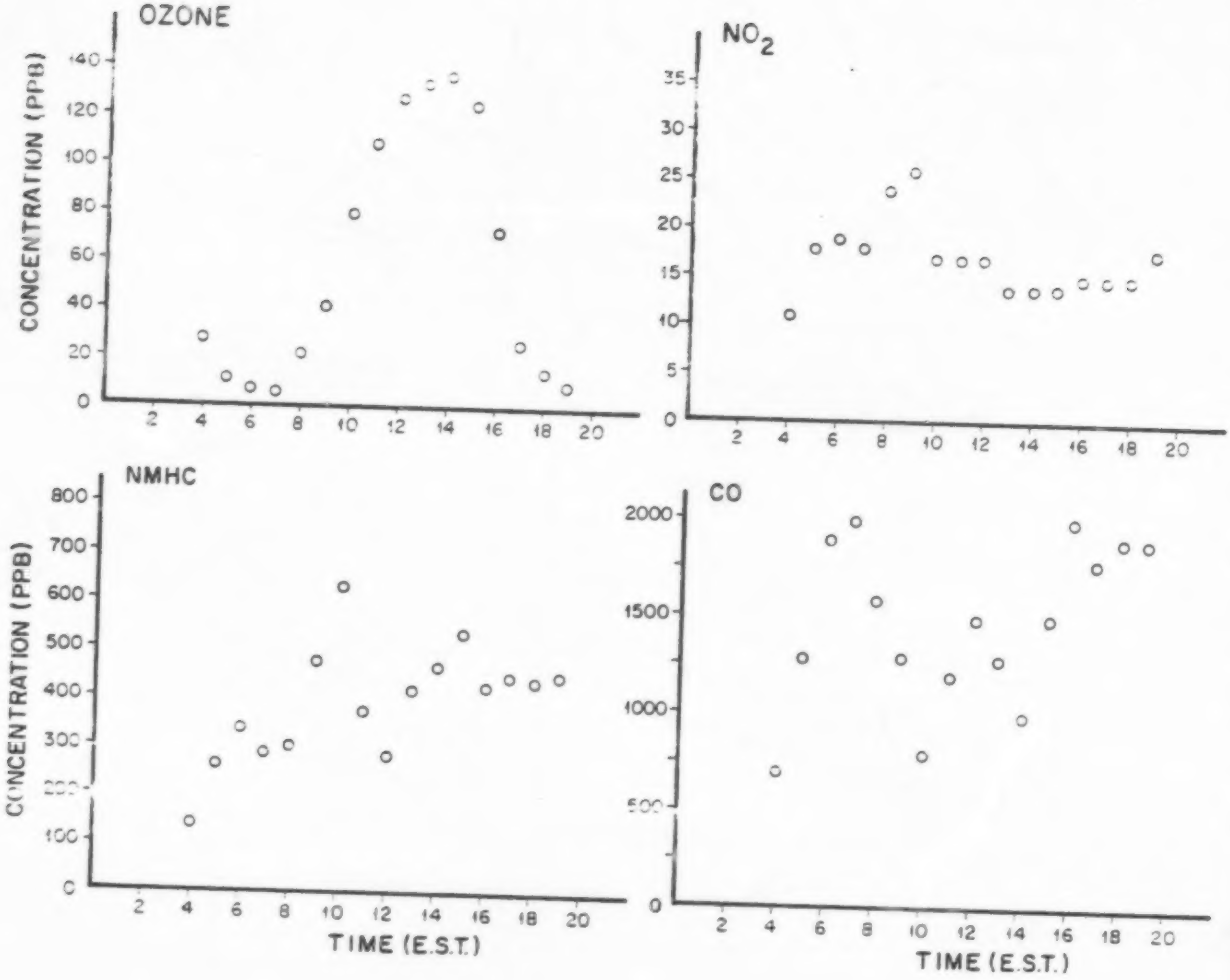


Figure 5.3 Diurnal Plots of Observed Pollutant Concentrations at the Southwest Corner Grid on JD80198(071680)

5.2 Input Data for JD80203(072180)

Examination of the daily surface weather map in terms of large-scale synoptic features, shown in Figure 5.1b, reveals that a "Bermuda high" extended westward to the southern Midwest. A warm front, with waves of low pressure on it, ran nearly east-west from Maine to well north of Lake Ontario, where a cold front ran southward then southwestward to mid-country. The surface winds during the day, listed in Table 5.6, were generally from the southwest to south-southwest with wind speeds ranging from 4 to 5 m/s. The other meteorological parameters for each hour of simulation are listed in Tables 5.7 and 5.8. The initial surface distribution of pollutants - ozone, nitrogen dioxide, non-methane hydrocarbons and carbon monoxide are shown in Figure 5.4, respectively. The vertical pollutant gradients determined from aircraft spiral data and the concentrations adopted for the top of the modeling region are provided in Table 5.9. The boundary concentrations at all four sides of the model domain varied both spatially and temporally. In Figure 5.5, the diurnal variations of the pollutant species at the surface level for the southwest corner cell are shown. On this day, the ozone concentrations measured over Connecticut often exceeded 200 ppb with a maximum measured hourly concentration of 303 ppb at Stratford, Connecticut. In Table 5.10 are listed the hourly highest and second highest measured concentrations along with their time of occurrence and their location.

5.3 Input Data for JD80204(072280)

On this day the synoptic-scale features, shown in Figure 5.1c, are as follows. The "Bermuda High" extended westward from the Atlantic. A broad area of low pressure was positioned over the northern New York-New England/Canadian border region, lying on a frontal system that stretched from Maine (warm-frontal) westward, then southward to Tennessee (cold-frontal) and on to Texas. The winds generally varied from a south-southwest to southerly direction at speeds ranging from 3.5 to 5.5 m/s. The vector-averaged hourly wind speeds and directions are listed in Table 5.11. The other input meteorological parameters are listed in Tables 5.12 and 5.13. The initial surface distribution of pollutants are shown in Figure 5.6. The pollutant concentration gradients and the concentration at the top of the modeling region are provided in Table 5-14.

TABLE 5.6

Vector-Averaged Hourly Winds for JD80203(072180) Simulation

HOUR	WIND SPEED (m/s)	WIND DIRECTION (°)
0400 - 0500	3.67	232
0500 - 0600	3.84	239
0600 - 0700	4.19	244
0700 - 0800	4.07	235
0800 - 0900	4.24	244
0900 - 1000	3.46	240
1000 - 1100	3.92	238
1100 - 1200	4.36	233
1200 - 1300	4.33	232
1300 - 1400	4.58	227
1400 - 1500	4.95	222
1500 - 1600	5.07	205
1600 - 1700	5.13	204
1700 - 1800	5.13	199
1800 - 1900	5.08	206
1900 - 2000	4.72	217

TABLE 5.7

Hourly Diffusion Break (Mixing Height), Region and Vertical Cell Top Heights for JD80203(072180) Simulation

HOUR	DIFFUSION BREAK (m)	REGION TOP (m)	TOP OF CELL (m)		
			3	2	1
0400 - 0500	285	1000	285	190	95
0500 - 0600	300	1000	300	200	100
0600 - 0700	360	1000	360	240	120
0700 - 0800	445	1030	435	290	145
0800 - 0900	570	1110	570	380	190
0400 - 1000	660	1160	660	440	220
1000 - 1100	710	1160	660	440	220
1100 - 1200	840	1250	750	750	250
1200 - 1300	1195	1370	870	580	290
1300 - 1400	1535	1535	1035	690	345
1400 - 1500	1670	1670	1170	780	390
1500 - 1600	1805	1805	1305	870	435
1600 - 1700	1895	1895	1395	930	465
1700 - 1800	1850	1895	1395	930	465
1800 - 1900	1500	1895	1395	930	465
1900 - 2000	960	1895	960	640	320

TABLE 5.8

Metscalar Input Parameters for JD80203(072180) Simulation

	TEMPERATURE GRADIENT (°K/m)					
HOUR	BELOW	ABOVE	EXPOSURE INDEX	PHOTOLYSIS RATE	CONCENTRATION OF WATER VAPOR (PPM)	ATMOSPHERIC PRESSURE (ATM)
0400-0500	.0029	-.0016	-1	.0010	17172.0	1.0025
0500-0600	.0029	-.0016	0	.0945	17807.0	1.0030
0600-0700	.0008	-.0032	0	.2242	17800.0	1.0035
0700-0800	-.0011	-.0046	0	.3539	17790.0	1.0037
0800-0900	-.0036	-.0064	1	.4444	18339.0	1.0038
0900-1000	-.0060	-.0083	1	.4898	18345.0	1.0033
1000-1100	-.0079	-.0082	2	.5169	18909.0	1.0029
1100-1200	-.0098	-.0081	2	.5367	18197.0	1.0033
1200-1300	-.0097	-.0080	2	.5447	18357.0	1.0030
1300-1400	-.0097	-.0079	2	.5310	18363.0	1.0025
1400-1500	-.0100	-.0055	1	.4999	18376.0	1.0021
1500-1600	-.0102	-.0029	1	.4430	17830.0	1.0014
1600-1700	-.0092	-.0044	0	.3416	17838.0	1.0010
1700-1800	-.0080	-.0059	0	.1712	17850.0	1.0008
1800-1900	-.0068	-.0076	0	.0113	17208.0	1.0004
1900-2000	-.0068	-.0076	0	.0010	16586.0	1.0007

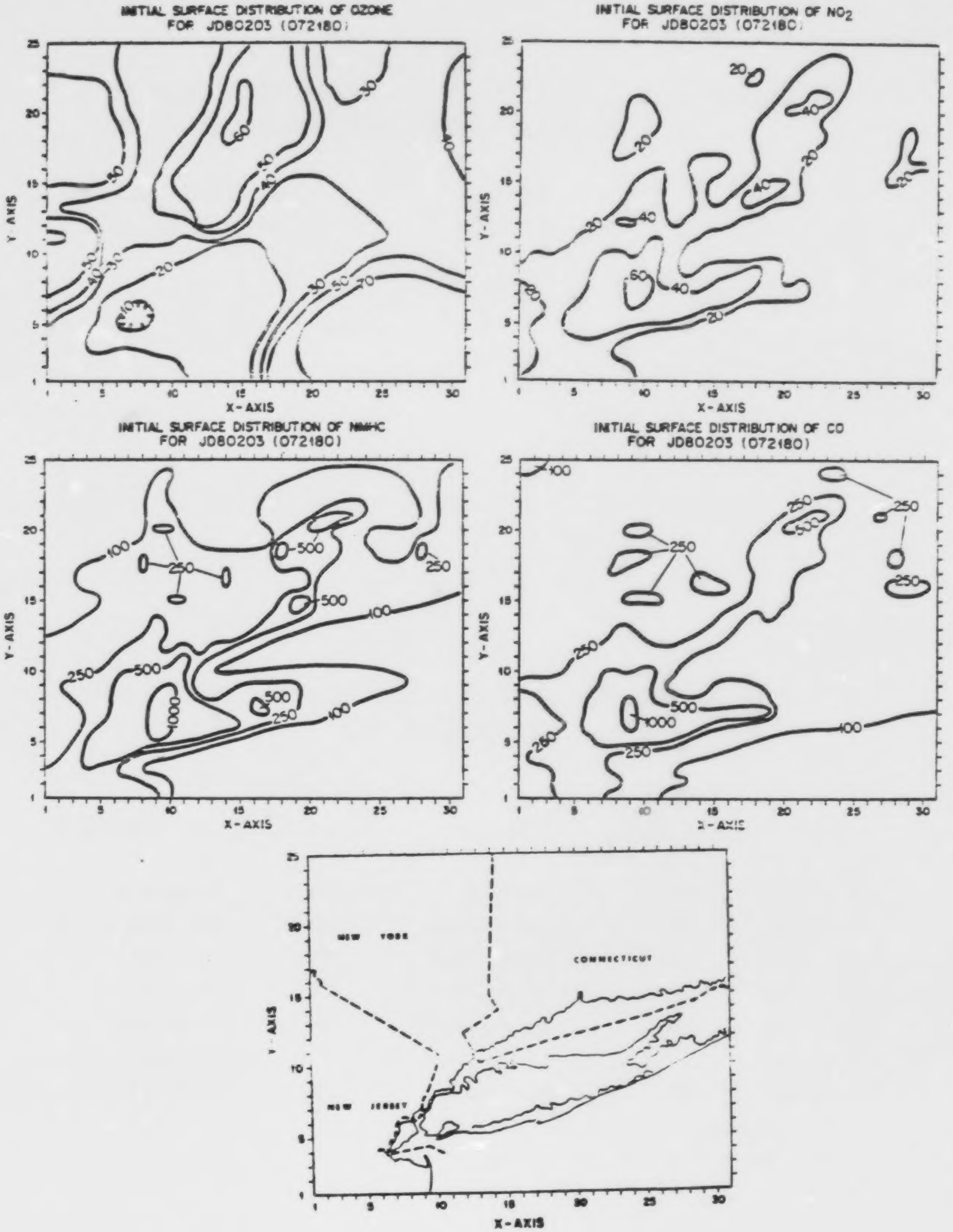

INITIAL SURFACE DISTRIBUTION OF OZONE
FOR JD80203 (072180)
INITIAL SURFACE DISTRIBUTION OF NO2
FOR JD80203 (072180)
INITIAL SURFACE DISTRIBUTION OF NMHC
FOR JD80203 (072180)
INITIAL SURFACE DISTRIBUTION OF CO
FOR JD80203 (072180)
X-AXIS
Y-AXIS
NEW YORK
CONNECTICUT
NEW JERSEY

Figure 5.4 Initial Pollutant Distribution on JD80203(072180)

TABLE 5.9

Pollutant Gradients in the Vertical and Concentrations at the Top of the Modeling Region for JD80203(072180)

Pollutant	Gradient (ppb/100m)	Concentration at the Top of the Modeling Region (ppb)
O_3	7.43	74
NO_2	-5.44	4
NMHC*	-11.72	50
CO	-50.0	20

*ppbc/100 m

TABLE 5.10

Hourly Highest and Second Highest Ozone Concentrations Measured on JD80203(072180)

HOUR	HIGHEST CONCENTRATION (ppb)	STATION	2nd HIGHEST CONCENTRATION (ppb)	STATION
1200 - 1300	230	Derby	202	Hempstead
1300 - 1400	227	Stony Brook	224	Stratford
1400 - 1500	240	Stony Brook	229	Stratford
1500 - 1600	303*	Stratford	195	Middletown
1600 - 1700	235	New Haven	224	Stratford
1700 - 1800	262**	Middletown	174	Stratford
1800 - 1900	200	Middletown	185	Hartford

* Highest for the day

** Second highest for the day

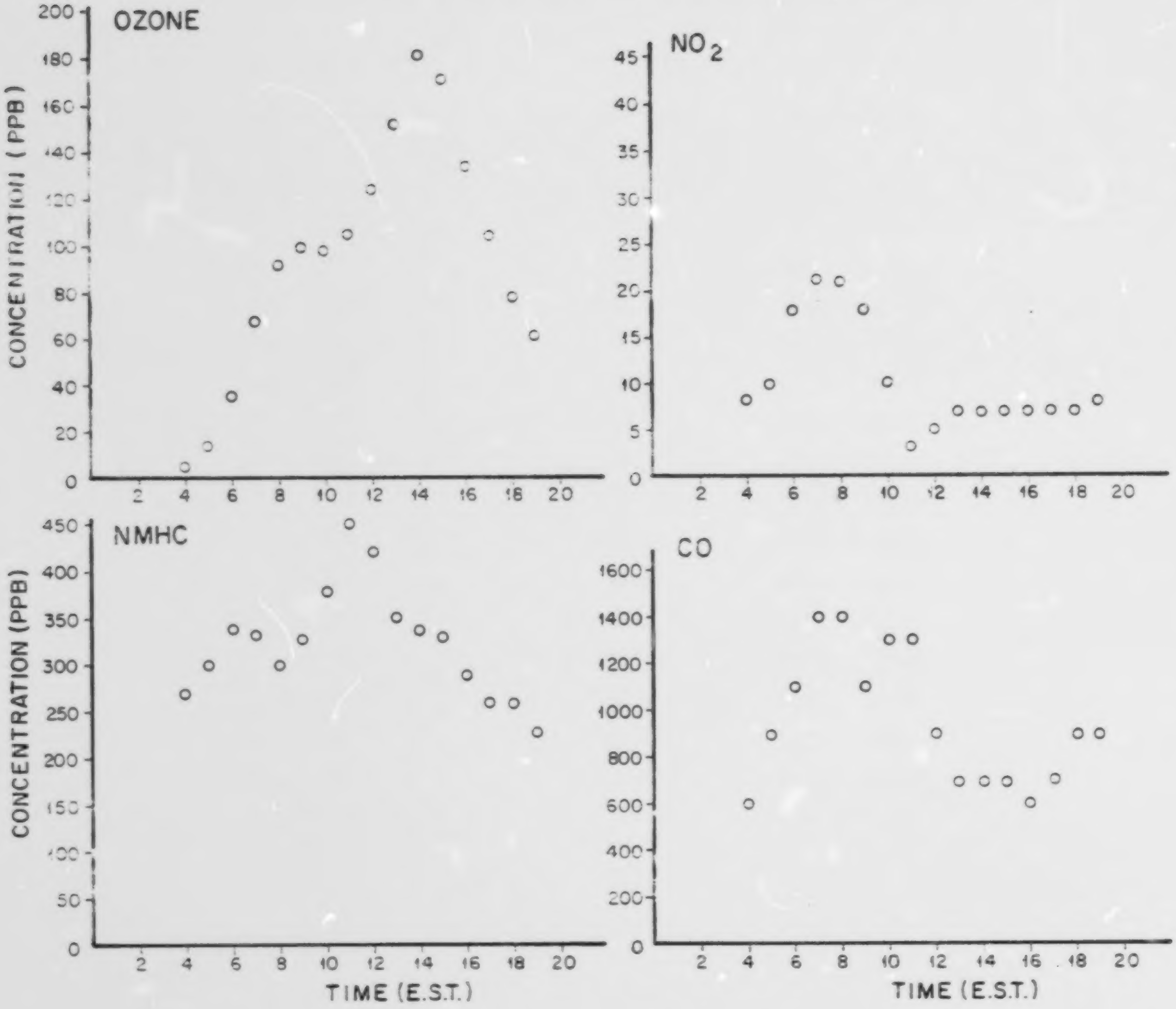


Figure 5.5 Diurnal Plot of Observed Pollutant Concentrations at the Southwest Corner Grid on JD80203(072180)

TABLE 5.11

Vector-Averaged Hourly Winds for JD80204(072280) Simulation

HOUR	WIND SPEED (m/s)	WIND DIRECTION (°)
0400 - 0500	3.61	231
0500 - 0600	3.37	225
0600 - 0700	3.21	236
0700 - 0800	3.62	238
0800 - 0900	3.98	246
0900 - 1000	3.96	227
1000 - 1100	4.62	235
1100 - 1200	4.43	227
1200 - 1300	4.52	224
1300 - 1400	4.69	233
1400 - 1500	5.66	220
1500 - 1600	5.51	217
1600 - 1700	5.48	216
1700 - 1800	5.66	214
1800 - 1900	5.23	219
1900 - 2000	4.60	221

TABLE 5.12

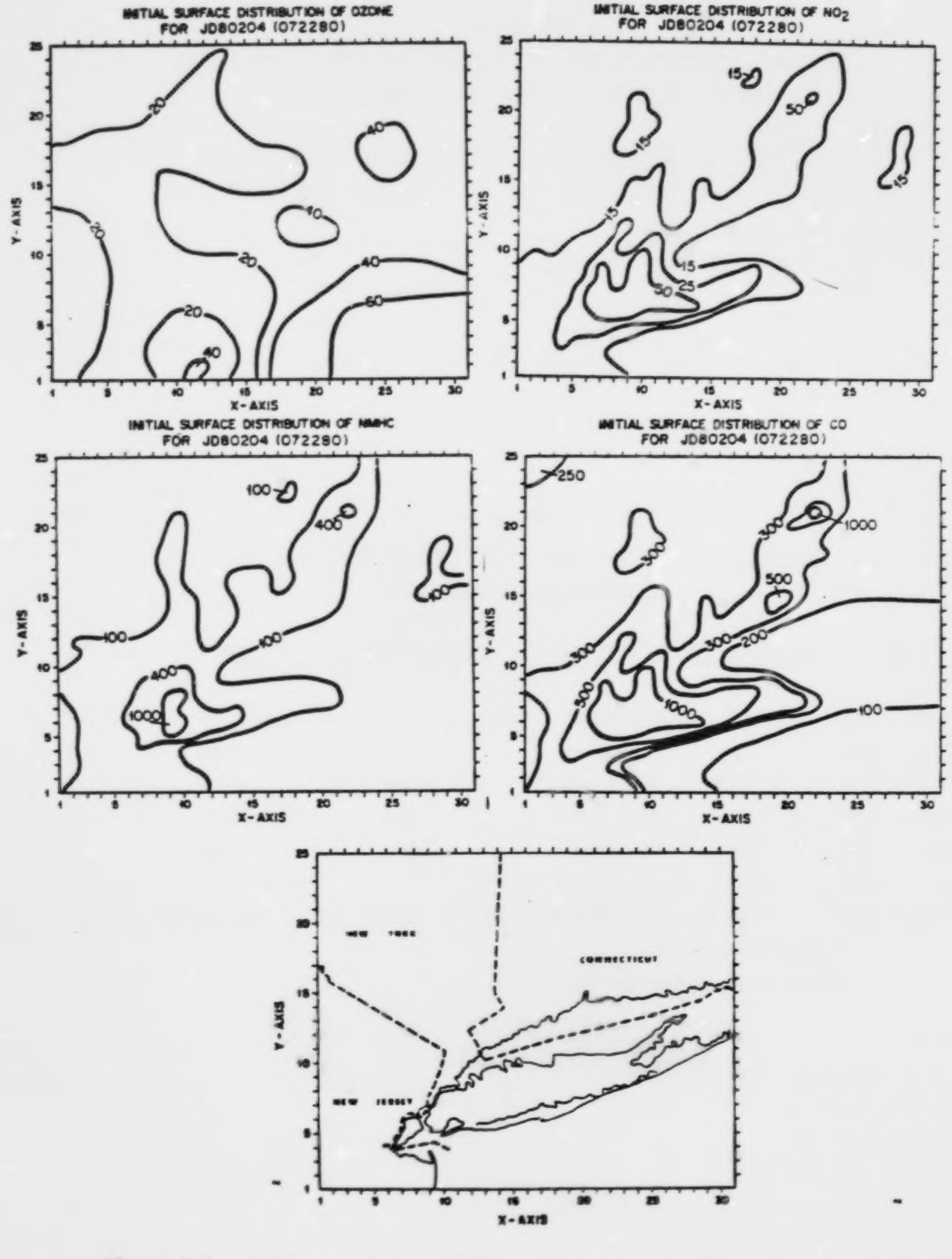
Hourly Diffusion Break (Mixing Height), Region and Vertical Cell Top Heights for JD80204(072280) Simulation

HOUR	DIFFUSION BREAK (m)	REGION TOP (m)	TOP OF CELL (m) 3	2	1
0400 - 0500	315	1000	315	210	105
0500 - 0600	405	1000	405	270	135
0600 - 0700	555	1100	555	370	185
0700 - 0800	705	1205	705	470	235
0800 - 0900	810	1310	810	540	220
0900 - 1000	870	1370	870	580	290
1000 - 1100	950	1370	870	580	290
1100 - 1200	1040	1385	885	590	295
1200 - 1300	1180	1430	930	620	310
1300 - 1400	1400	1475	975	650	325
1400 - 1500	1595	1595	1095	730	365
1500 - 1600	1625	1625	1125	750	375
1600 - 1700	1625	1625	1125	750	375
1700 - 1800	1550	1625	1125	750	375
1800 - 1900	1360	1625	1125	750	375
1900 - 2000	1180	1625	1125	750	325

TABLE 5.13

Metscalar Input Parameters for JD80204(072280) Simulation

HOUR	TEMPERATURE GRADIENT (°K/m) BELOW	TEMPERATURE GRADIENT (°K/m) ABOVE	EXPOSURE INDEX	PHOTOLYSIS RATE	CONCENTRATION OF WATER VAPOR (PPM)	ATMOSPHERIC PRESSURE (ATM)
0400-0500	-.0005	-.0043	0	.0010	15003.0	0.9814
0500-0600	-.0005	-.0043	0	.0010	15007.0	0.9814
0600-0700	-.0024	-.0065	1	.1236	14999.0	0.9819
0700-0800	-.0055	-.0056	1	.2830	14993.0	0.9821
0800-0900	-.0075	-.0053	1	.3923	14999.0	0.9819
0900-1000	-.0095	-.0049	2	.4593	15007.0	0.9814
1000-1100	-.0108	-.0053	2	.5003	15007.0	0.9813
1100-1200	-.0119	-.0057	2	.5245	15013.0	0.9810
1200-1300	-.0114	-.0061	2	.5371	15491.0	0.9806
1300-1400	-.0110	-.0065	1	.5392	16093.0	0.9798
1400-1500	-.0107	-.0066	1	.5284	16602.0	0.9790
1500-1600	-.0106	-.0067	1	.4943	16619.0	0.9783
1600-1700	-.0097	-.0068	0	.4340	16631.0	0.9777
1700-1800	-.0090	-.0069	0	.3316	16636.0	0.9775
1800-1900	-.0081	-.0069	0	.1653	16636.0	0.9775
1900-2000	-.0081	-.0069	-1	.0097	16647.0	0.9771



INITIAL SURFACE DISTRIBUTION OF OZONE FOR JD80204 (072280)

INITIAL SURFACE DISTRIBUTION OF NO_2 FOR JD80204 (072280)

INITIAL SURFACE DISTRIBUTION OF NMHC FOR JD80204 (072280)

INITIAL SURFACE DISTRIBUTION OF CO FOR JD80204 (072280)

Y-AXIS
X-AXIS
1
5
10
15
20
25
30
20
40
60
15
25
30
50
100
400
1000
250
300
500
200
NEW YORK
CONNECTICUT
NEW JERSEY

Figure 5.6 Initial Pollutant Distribution on JD80204(072280)

TABLE 5.14

Pollutant Gradients in the Vertical and Concentrations at the Top of the Modeling Region for JD80204(072280)

Pollutant	Gradient (ppb/100m)	Concentration at the top of the Modeling Region (ppb)
O_3	9.43	60
NO_2	-6.04	5
NMHC*	-43.36	30
CO	-50.0	20

*ppbc/100 m

TABLE 5.15

Hourly Highest and Second Highest Ozone Concentrations Measured on JD80204(072280)

HOUR	HIGHEST CONCENTRATION (ppb)	STATION	2nd HIGHEST CONCENTRATION (ppb)	STATION
1200 - 1300	168	Stratford	139	Derby
1300 - 1400	218	Stratford	200	New Haven
1400 - 1500	227**	New Haven	226	Stratford
1500 - 1600	220	Middletown	212	Hartford
1600 - 1700	240*	Hartford	150	Middletown
1700 - 1800	160	Hartford	148	Litchfield
1800 - 1900	148	Litchfield	118	Susan Wagner

* Highest for the day

** Second highest for the day

The highest and second highest measured hourly ozone concentrations for this day, listed in Table 5.15, indicate a maximum of 240 ppb at Hartford, Connecticut with concentrations in excess of 200 ppb at other locations over Connecticut. The concentrations adopted for the pollutants at the southwest boundary cell are shown in Figure 5.7.

5.4 Input Data for JD80219(080680)

On this day the synoptic situation, shown in Figure 5.1d, is slightly different from the previous cases. A break-off extension of the "Bermuda" high was centered over West Virginia. A frontal zone was draped north of the border to a low pressure near James Bay.

The vector-averaged hourly winds are listed in Table 5.16, with speeds ranging from about 3 to 5 m/s from a south-southwest to southwesterly direction. The other input meteorological parameters are listed in Tables 5.17 and 5.18. The pollutant gradients and the concentration at the top of the modeling region are listed in Table 5.19. The initial surface distributions of the pollutants for the simulation day are shown in Figure 5.8. The highest and second highest measured hourly ozone concentrations are listed in Table 5.20 with the highest value of 249 ppb. The hourly boundary concentrations for the southwest corner grid are shown in Figure 5.9 to provide an example of the typical values used in this simulation.

5.5 Input Data for JD80221(080880)

The synoptic weather pattern for this day, shown in Figure 5.1e, consists of a double-structured "Bermuda" high with centers over the Atlantic and West Virginia. A frontal system arched across the northern part of the country. A high pressure center was found over James Bay, with a weak low pressure on the stationary portion of the front over Lake Superior.

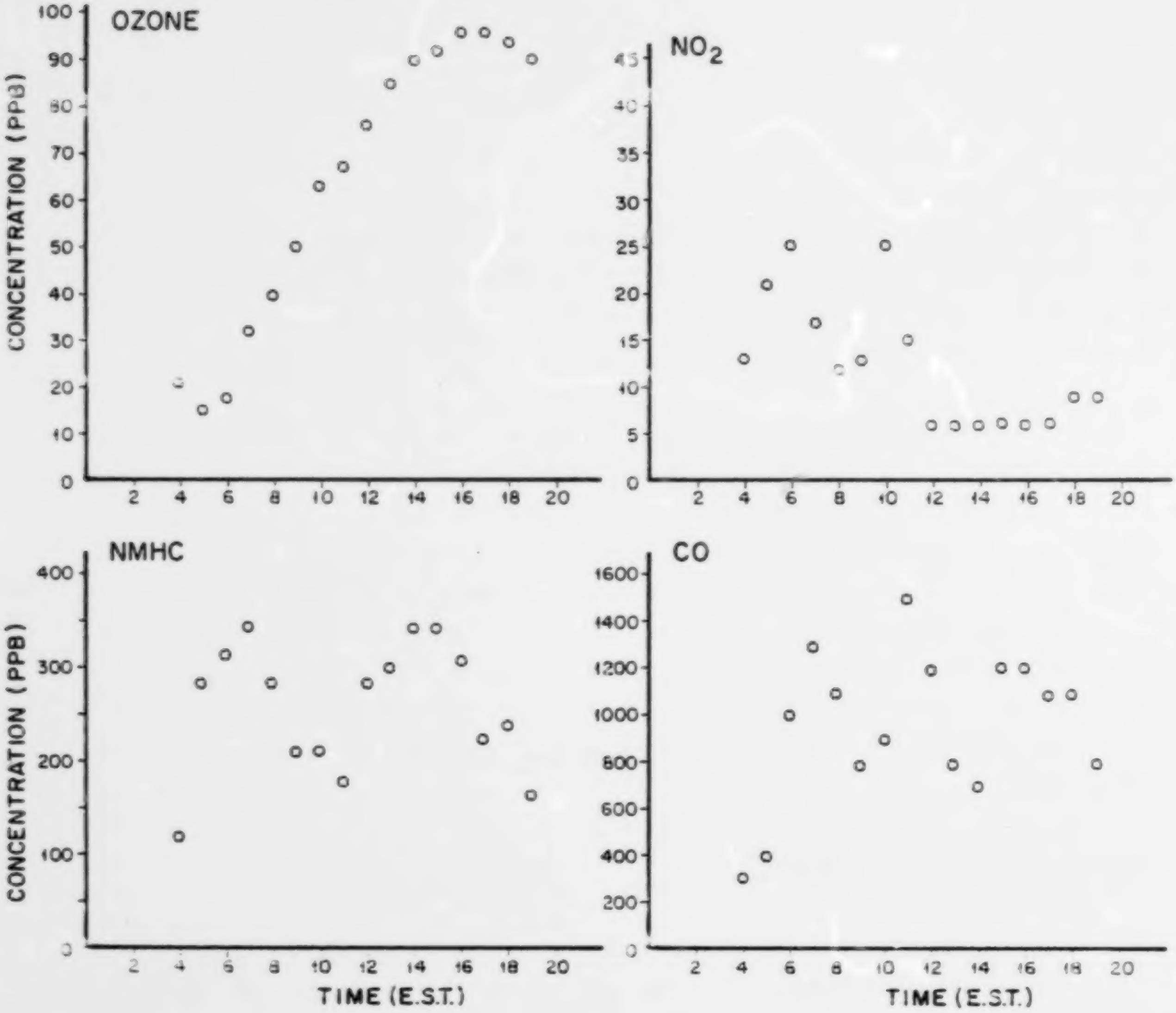


Figure 5.7 Diurnal Plot of Observed Pollutant Concentrations at the Southwest Corner Grid on JD80204(072280)

TABLE 5.16

Vector-Averaged Hourly Winds for JD80219(080680) Simulation

HOUR	WIND SPEED (m/s)	WIND DIRECTION (°)
0400 - 0500	3.47	218
0500 - 0600	2.80	225
0600 - 0700	3.51	259
0700 - 0800	3.42	260
0800 - 0900	2.91	231
0100 - 1000	2.79	244
1000 - 1100	3.44	223
1100 - 1200	3.73	237
1200 - 1300	3.27	220
1300 - 1400	3.71	234
1400 - 1500	4.10	234
1500 - 1600	4.51	239
1600 - 1700	4.97	238
1700 - 1800	4.41	231
1800 - 1900	3.96	247
1900 - 2000	3.59	251

TABLE 5.17

Hourly Diffusion Break (Mixing Height), Region and Vertical Cell Top Heights for JD80219(080680) Simulation

HOUR	DIFFUSION BREAK (m)	REGION TOP (m)	TOP OF CELL (m) 3	2	1
0400 - 0500	120	1000	120	80	40
0500 - 0600	165	1000	165	110	55
0600 - 0700	225	1000	225	150	75
0700 - 0800	315	1000	315	210	105
0800 - 0900	450	1000	450	300	150
0900 - 1000	600	1050	600	400	200
1000 - 1100	750	1105	705	470	235
1100 - 1200	945	1150	750	500	250
1200 - 1300	1145	1195	795	530	265
1300 - 1400	1240	1240	840	560	280
1400 - 1500	1240	1240	840	560	280
1500 - 1600	1240	1240	840	560	280
1600 - 1700	1240	1240	840	560	280
1700 - 1800	1110	1240	795	530	265
1800 - 1900	920	1240	750	500	250
1900 - 2000	800	1240	720	480	240

TABLE 5.18

Metscalar Input Parameters for JD80219(080680) Simulation

HOUR	TEMPERATURE BELOW	GRADIENT (°K/m) ABOVE	EXPOSURE INDEX	PHOTOLYSIS RATE	CONCENTRATION OF WATER VAPOR (PPM)	ATMOSPHERIC PRESSURE (ATM)
0400-0500	.0026	-.0046	0	.0010	15430.0	0.9845
0500-0600	.0026	-.0046	0	.0010	16013.0	0.9845
0600-0700	-.0044	-.0051	1	.0853	15424.0	0.9852
0700-0800	-.0054	-.0045	1	.2360	15415.0	0.9857
0800-0900	-.0065	-.0054	1	.3568	16002.0	0.9855
0900-1000	-.0079	-.0064	2	.4345	16497.0	0.9856
1000-1100	-.0084	-.0061	2	.4842	17116.0	0.9856
1100-1200	-.0091	-.0058	2	.5142	17652.0	0.9853
1200-1300	-.0097	-.0056	2	.5300	17652.0	0.9851
1300-1400	-.0104	-.0052	1	.5278	17657.0	0.9846
1400-1500	-.0104	-.0048	1	.5081	18321.0	0.9845
1500-1600	-.0104	-.0042	1	.4699	18332.0	0.9840
1600-1700	-.0098	-.0049	0	.4034	18339.0	0.9839
1700-1800	-.0092	-.0056	0	.2886	17682.0	0.9838
1800-1900	-.0086	-.0062	0	.1178	16029.0	0.9838
1900-2000	-.0086	-.0062	0	.0010	16029.0	0.9840

TABLE 5.19

Pollutant Gradients in the Vertical and Concentrations at the Top of the Modeling Region for JD80219(080680)

Pollutant	Gradient (ppb/100m)	Concentration at the Top of the Modeling Region (ppb)
O_3	3.70	65
NO_2	-1.73	2
NMHC*	-14.82	30
CO	-50.00	20

*ppbc/100 m

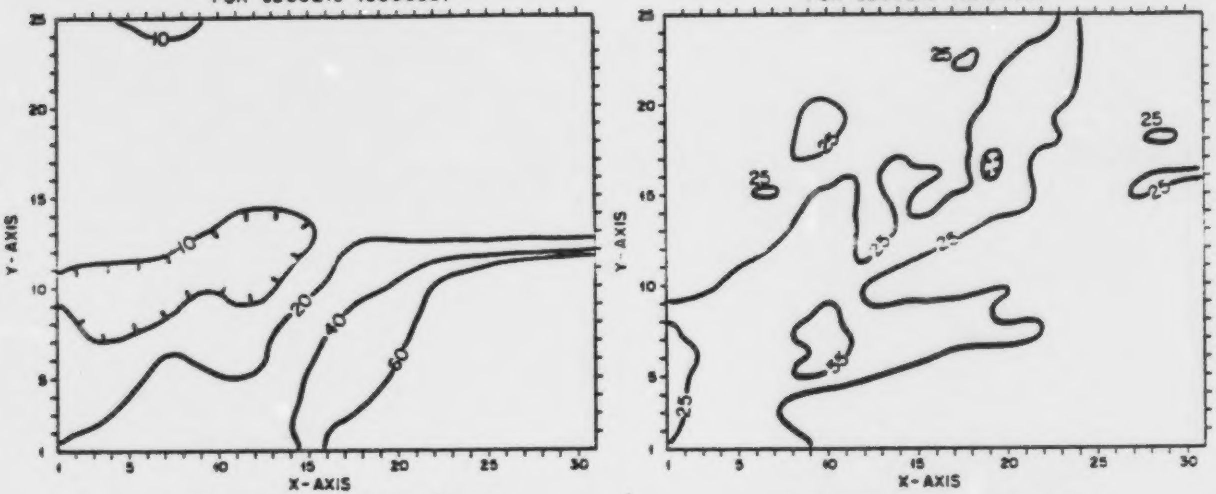
TABLE 5.20

Hourly Highest and Second Highest Ozone Concentrations Measured on JD80219(080680)

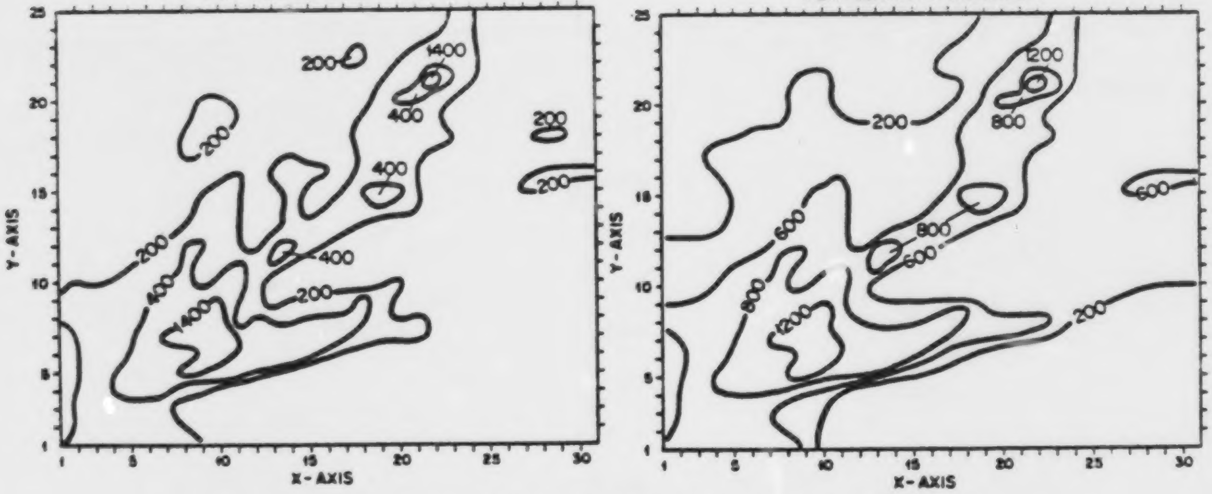
HOUR	HIGHEST CONCENTRATION	STATION	2nd HIGHEST CONCENTRATION	STATION
1200 - 1300	234	Stratford	180	Derby
1300 - 1400	249*	Stratford	182	Bridgeport
1400 - 1500	220**	Stratford	197	Derby
1500 - 1600	217	Derby	190	Stratford
1600 - 1700	201	Stratford	140	Derby
1700 - 1800	206	Stratford	137	Middletown
1800 - 1900	168	Stratford	101	Middletown

* Highest for the day

** Second highest for the day


INITIAL SURFACE DISTRIBUTION OF OZONE FOR JD80219 (080680)

INITIAL SURFACE DISTRIBUTION OF NO_2 FOR JD80219 (080680)


INITIAL SURFACE DISTRIBUTION OF NMHC FOR JD80219 (080680)

INITIAL SURFACE DISTRIBUTION OF CO FOR JD80219 (080680)

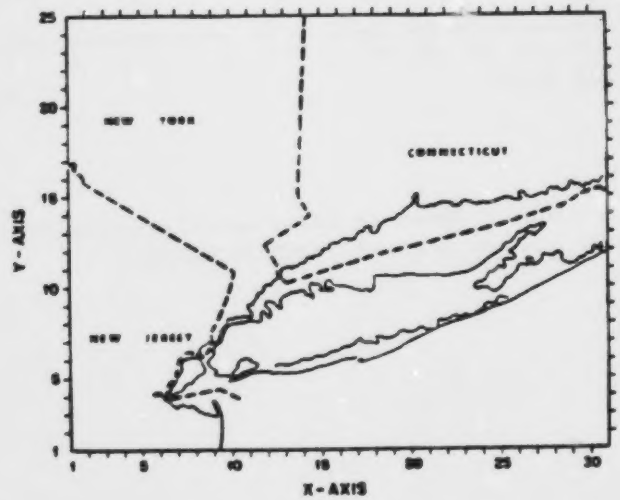

Y-AXIS
X-AXIS
NEW YORK
CONNECTICUT
NEW JERSEY

Figure 5.8 Initial Pollutant Distribution on JD80219(080680)

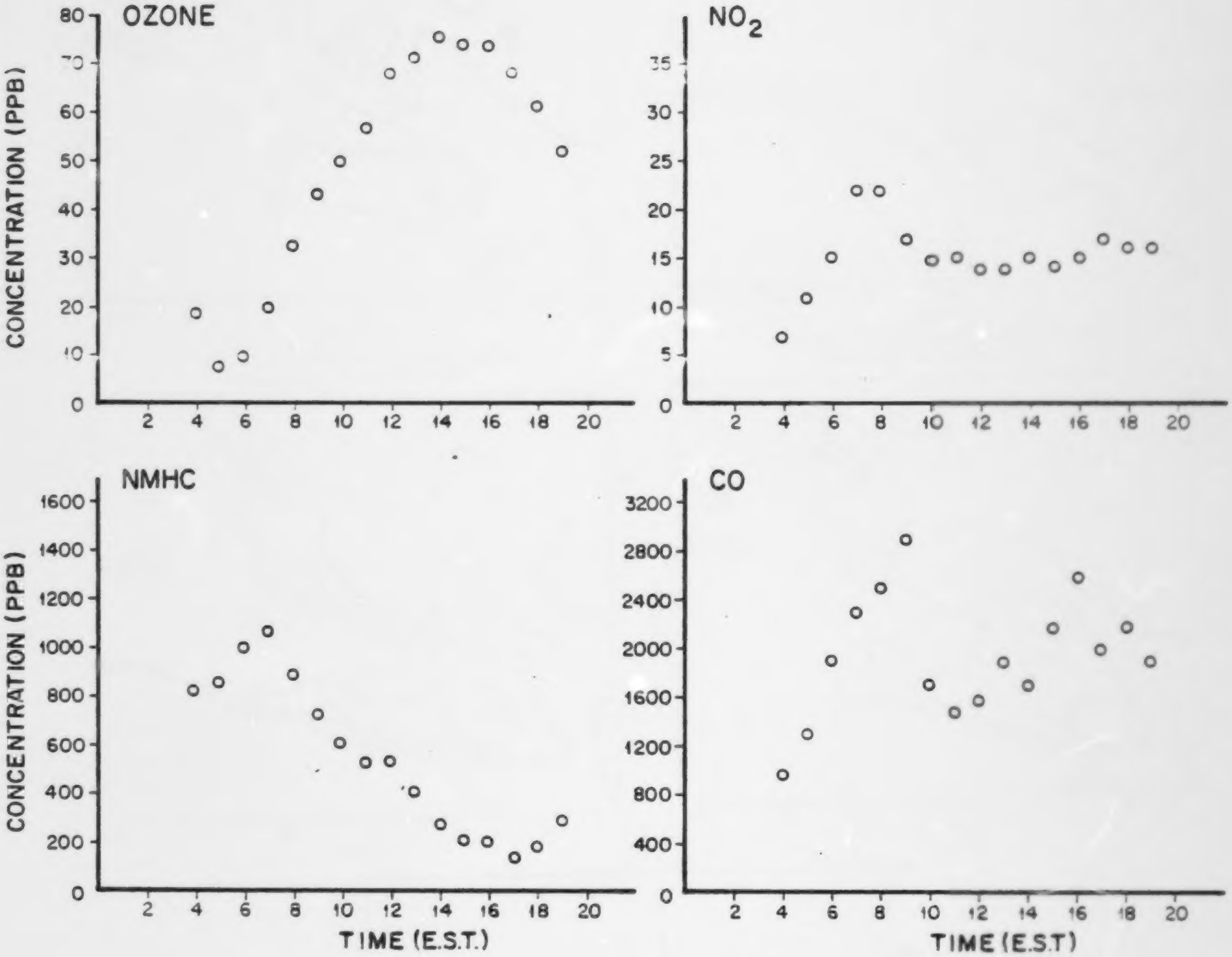


Figure 5.9   Diurnal Plot of Observed Pollutant Concentrations at the Southwest Corner Grid on JD80219(080680)

The hourly vector-averaged wind speeds and directions are listed in Table 5.21. The winds were from a south-southwesterly direction, with speeds ranging from 3.5 to 5 m/s. The other input meteorological parameters are listed in Tables 5.22 and 5.23. The mixing height reached a maximum of 1400 m. The pollutant gradients in the vertical are listed in Table 5.24 along with the concentrations at the top of the modeling region. The initial surface distributions of the pollutants for the simulation day are shown in Figure 5.10. The highest and second highest measured hourly ozone concentrations are listed in Table 5.25. The peak value was 246 ppb and exceedances of over 200 ppb are noted for other hours. Diurnal variation of the pollutant concentrations at the southwest corner grid are displayed in Figure 5.11.

TABLE 5.21

Vector-Averaged Hourly Winds for JD80221(080880) Simulation

HOUR	WIND SPEED (m/s)	WIND DIRECTION (°)
0600 - 0500	3.53	227
0500 - 0600	3.48	234
0600 - 0700	3.77	241
0700 - 0800	3.24	244
0800 - 0900	3.67	231
0900 - 1000	3.82	232
1000 - 1100	3.99	237
1100 - 1200	4.57	238
1200 - 1300	5.26	233
1300 - 1400	4.80	235
1400 - 1500	5.09	236
1500 - 1600	5.63	236
1600 - 1700	4.49	234
1700 - 1800	5.11	245
1800 - 1900	4.48	239
1900 - 2000	4.84	224

TABLE 5.22

Hourly Diffusion Break (Mixing Height), Region and Vertical Cell Top Heights for JD80221(080880) Simulation

HOUR	DIFFUSION BREAK (m)	REGION TOP (m)	TOP OF CELL (m) 3	2	1
0400 - 0500	345	1000	345	230	115
0500 - 0600	345	1000	345	230	115
0600 - 0700	345	1000	345	230	115
0700 - 0800	375	1000	375	250	125
0800 - 0900	405	1000	405	270	135
0900 - 1000	450	1040	450	300	150
1000 - 1100	540	1100	540	360	180
1100 - 1200	700	1160	660	440	220
1200 - 1300	1020	1280	780	520	260
1300 - 1400	1400	1400	900	600	300
1400 - 1500	1400	1400	900	600	300
1500 - 1600	1400	1400	900	600	300
1600 - 1700	1400	1400	900	600	300
1700 - 1800	1170	1400	795	530	265
1800 - 1900	940	1400	705	470	235
1900 - 2000	710	1400	630	420	210

TABLE 5.23

Metscalar Input Parameters for JD80204(080880) Simulation

HOUR	TEMPERATURE GRADIENT (°K/m) BELOW	TEMPERATURE GRADIENT (°K/m) ABOVE	EXPOSURE INDEX	PHOTOLYSIS RATE	CONCENTRATION OF WATER VAPOR (PPM)	ATMOSPHERIC PRESSURE (ATM)
0400-0500	.0049	-.0069	0	.0010	16065.0	0.9813
0500-0600	.0049	-.0069	0	.0010	16065.0	0.9811
0600-0700	.0008	-.0075	1	.0848	16065.0	0.9810
0700-0800	.0008	-.0075	1	.2355	16065.0	0.9810
0800-0900	-.0039	-.0063	1	.3509	16065.0	0.9811
0900-1000	-.0084	-.0051	2	.4247	16072.0	0.9807
1000-1100	-.0099	-.0061	2	.4718	16072.0	0.9807
1100-1200	-.0112	-.0070	2	.5020	16083.0	0.9801
1200-1300	-.0106	-.0064	2	.5234	16093.0	0.9796
1300-1400	-.0101	-.0058	1	.5319	16603.0	0.9791
1400-1500	-.0098	-.0063	1	.5120	16614.0	0.9787
1500-1600	-.0096	-.0068	1	.4733	16126.0	0.9775
1600-1700	-.0093	-.0073	1	.4059	16136.0	0.9771
1700-1800	-.0090	-.0078	0	.2861	16143.0	0.9768
1800-1900	-.0088	-.0083	0	.1125	16659.0	0.9763
1900-2000	-.0088	-.0083	-1	.0010	16659.0	0.9761

TABLE 5.24

Pollutant Gradients in tne Vertical and Concentrations at the Top of the Modeling Region for JD80221(080880)

Pollutant	Gradient (ppb/100m)	Concentration at the Top of the Modeling Region (ppb)
O_3	5.69	70
NO_2	-2.08	6
NMHC*	-25.95	30
CO	-50.00	20

*ppbc/100 m

TABLE 5.25

Hourly Highest and Second Highest Ozone Concentrations Measured on JD80221(080880)

HOUR	HIGHEST CONCENTRATION (ppb)	STATION	2nd HIGHEST CONCENTRATION (ppb)	STATION
1200 - 1300	213	Stratford	180	Greenwich
1300 - 1400	246*	Stratford	170	Bridgeport
1400 - 1500	237**	Stratford	167	Bridgeport
1500 - 1600	236	Stratford	145	Stony Brook
1600 - 1700	197	Stratford	141	Derby
1700 - 1800	160	Stratford	132	Derby
1800 - 1900	143	Stratford	143	Middletown

* Highest for the day

** Second highest for the day

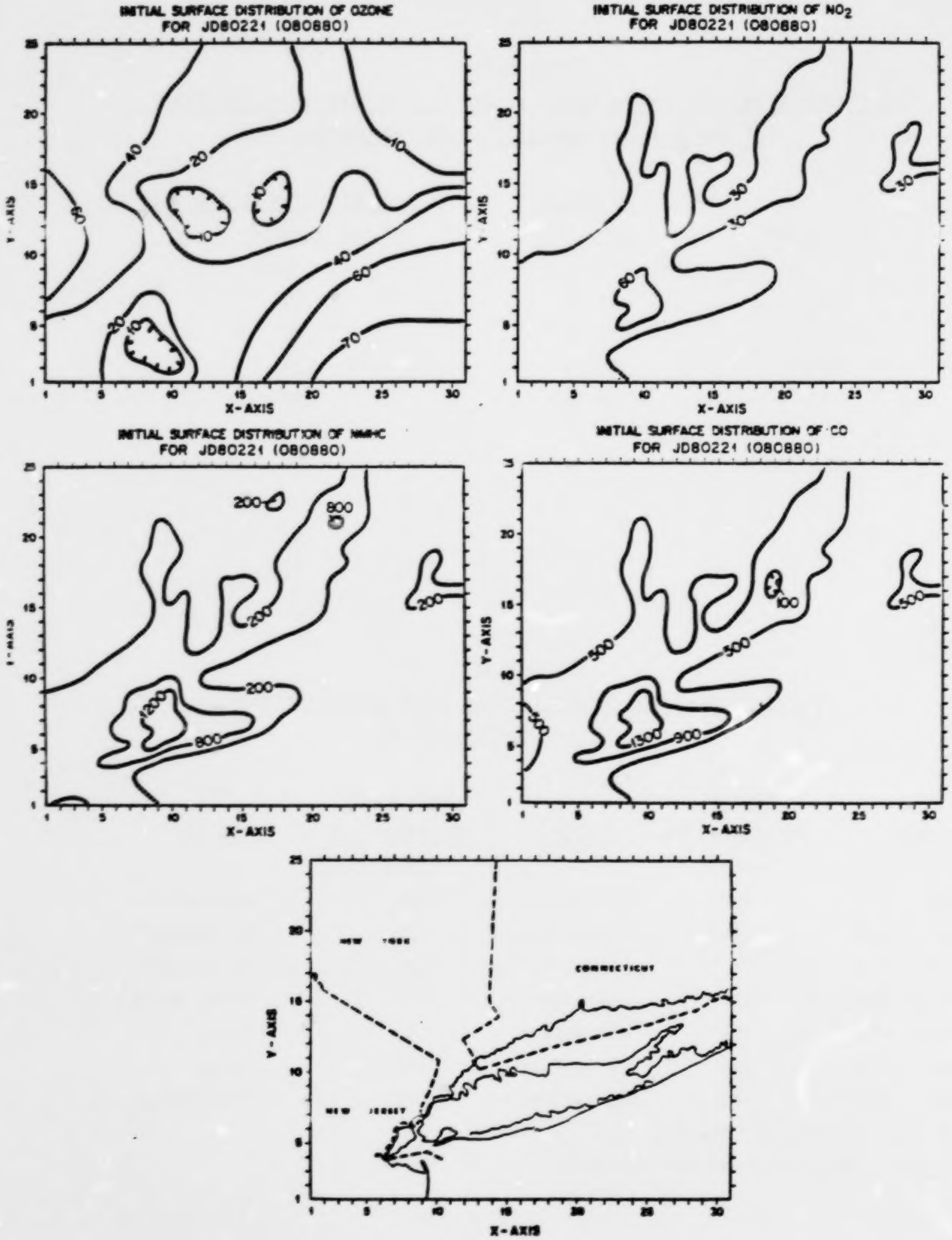


Figure 5.10 Initial Pollutant Distribution on JD80221(080880)

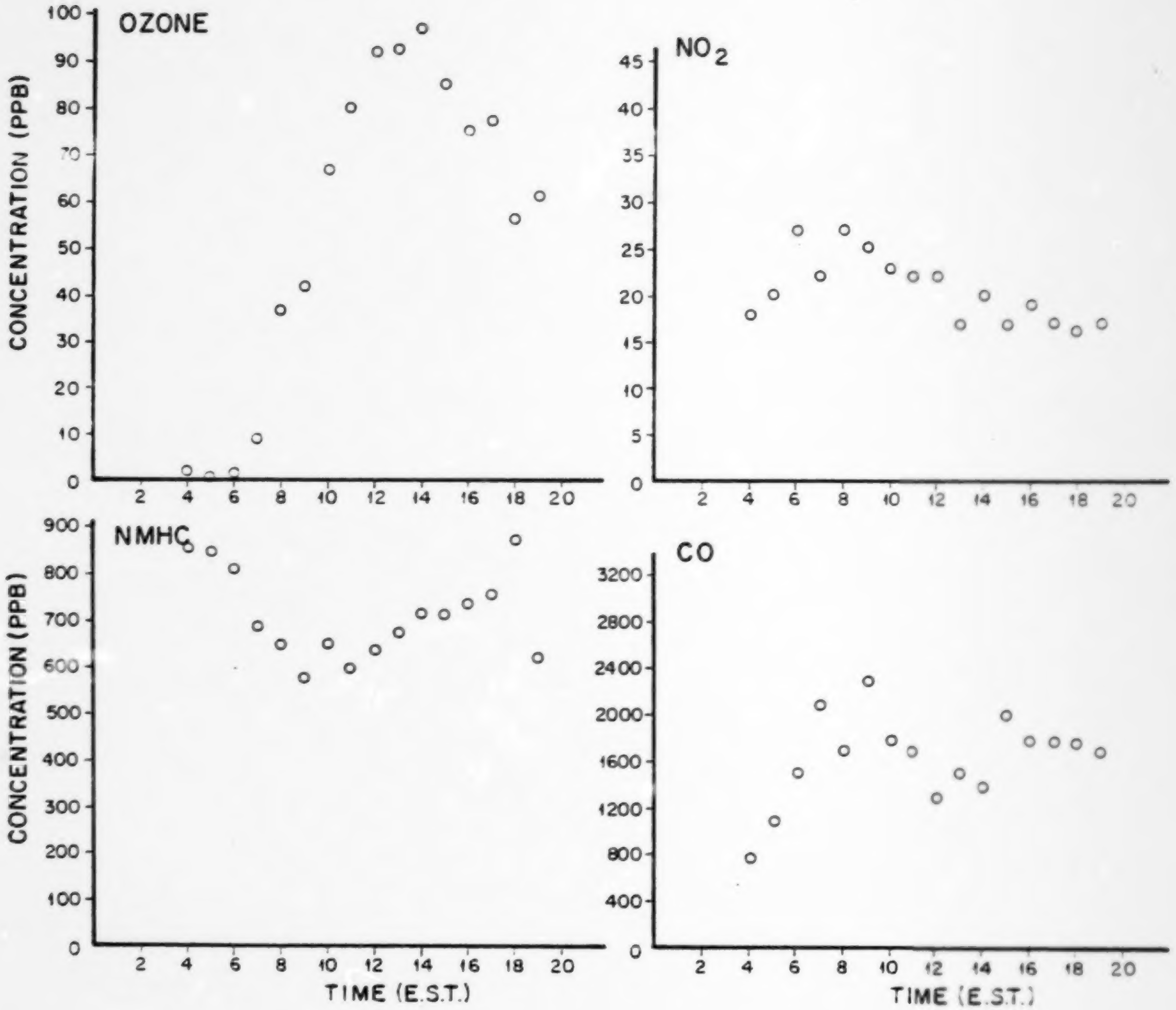


Figure 5.11 Diurnal Plot of Observed Pollutant Concentrations at the Southwest Corner Grid on JD80221(080880)

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CHAPTER 6

MODEL PERFORMANCE EVALUATION

The results of the UAM simulation for the five selected high ozone days are presented and discussed in this section. The model performance is evaluated on the basis of its overall predictive capability and its ability to capture the high concentration values through the application of various statistical measures recommended by the AMS workshop (Fox, 1981).

6.1 UAM Simulation of the Ozone Concentration Field for the Five Days

Using the model input data described in the previous chapter, the UAM was executed to provide hourly averaged ozone concentration fields for each of the five days. In Figures 6.1 to 6.5 are shown the isopleths of predicted ozone concentrations for selected hours when concentration maxima are expected to occur for each of the five days. One of the characteristic features of the five days simulated is the occurrence of a double peak over the modeling domain around the time of the occurrence of the ozone maximum with one peak over the northeastern portion of Connecticut and the other over the border areas of northeastern New Jersey-New York. Only in the case of JD80219 (080680) was there no clearly defined double peak. This may be due to the lower advection rate, and limited mixing in the vertical which could result in the merger of the two peaks. Also, in some instances, the peak concentration formed over the New Jersey-New York region is higher than the peak occurring over the Connecticut region suggesting a strong influence of pollutant transport through the southern and western boundaries.

6.2 Paired Comparisons - All Data

It should be noted that whereas the UAM predictions represent volume-averaged hourly concentration values (averaged over the cell volume specified in the program), the measured concentrations are at monitoring stations represented by points in space. Hence, perfect agreement between measured and predicted concentrations should be considered as fortuitous. To assess the model performance, the grid point nearest to the monitoring station is located and the predicted concentrations at this grid point are compared with the measurements

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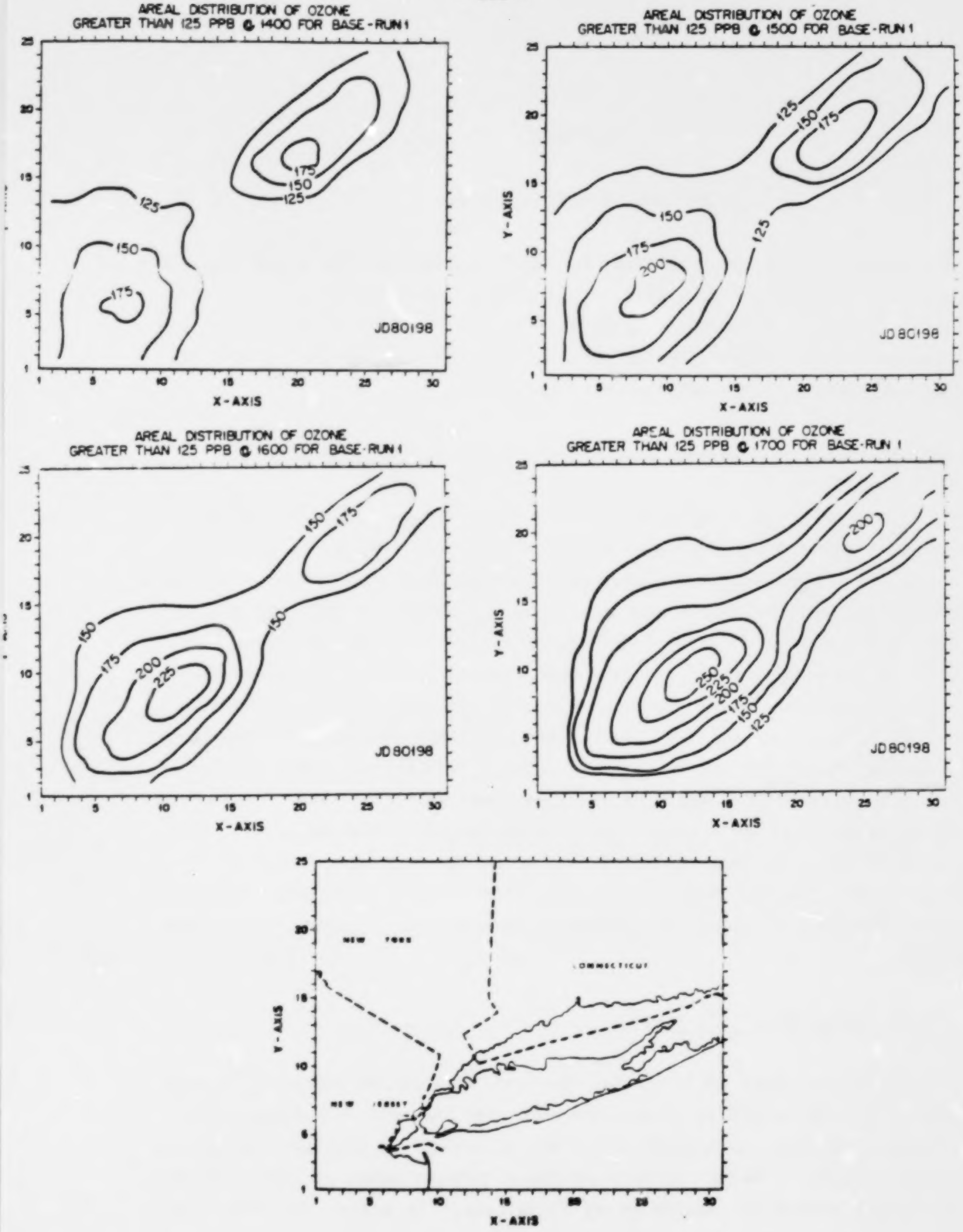
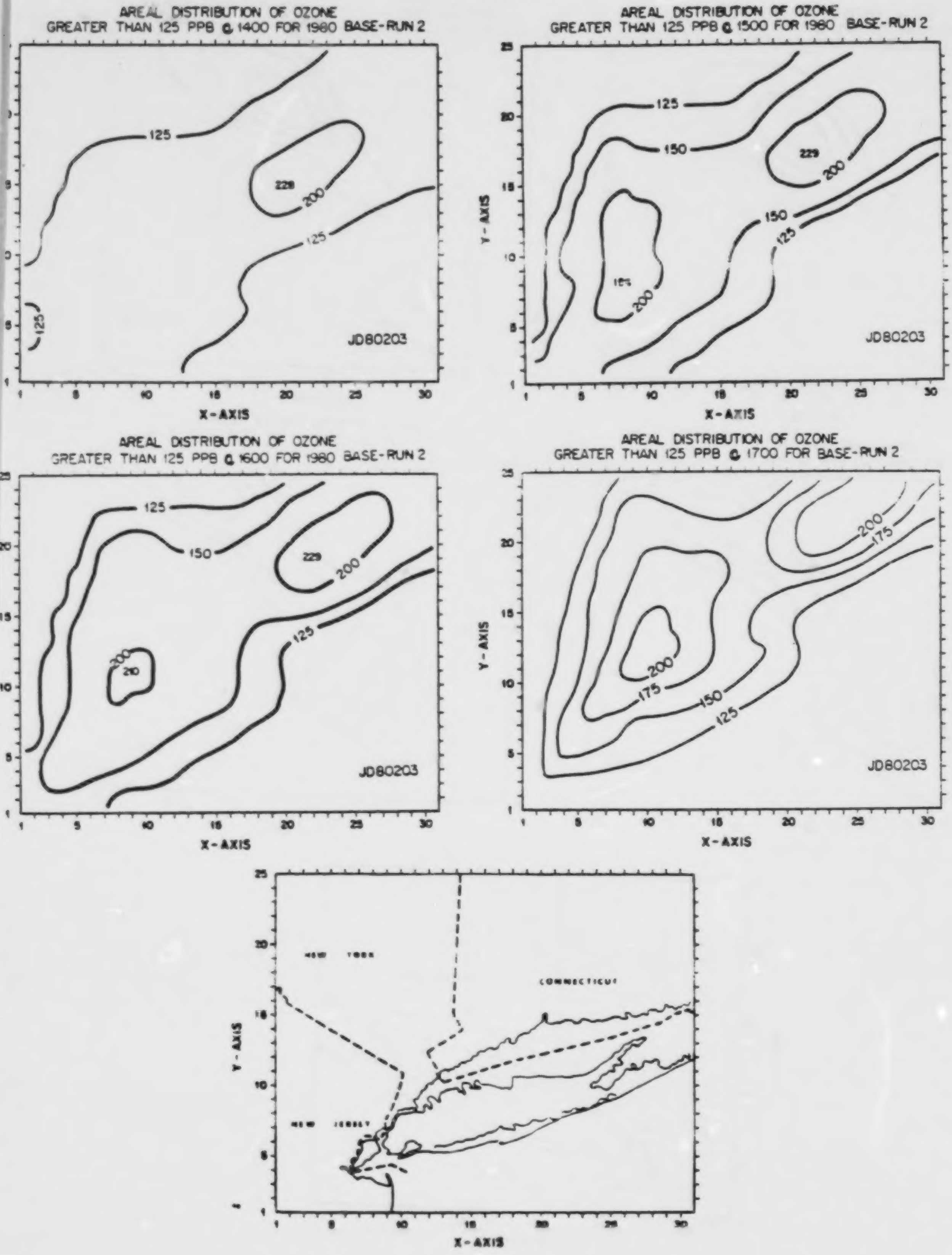


Figure 6.1 Areal Distribution of Ozone on JD80198(071680) from 1400 to 1700 Hrs.



AREAL DISTRIBUTION OF OZONE
GREATER THAN 125 PPB @ 1400 FOR 1980 BASE-RUN 2

AREAL DISTRIBUTION OF OZONE
GREATER THAN 125 PPB @ 1500 FOR 1980 BASE-RUN 2

AREAL DISTRIBUTION OF OZONE
GREATER THAN 125 PPB @ 1600 FOR 1980 BASE-RUN 2

AREAL DISTRIBUTION OF OZONE
GREATER THAN 125 PPB @ 1700 FOR BASE-RUN 2

Figure 6.2 Areal Distribution of Ozone on JD80203(072180) from 1400 to 1700 Hrs.

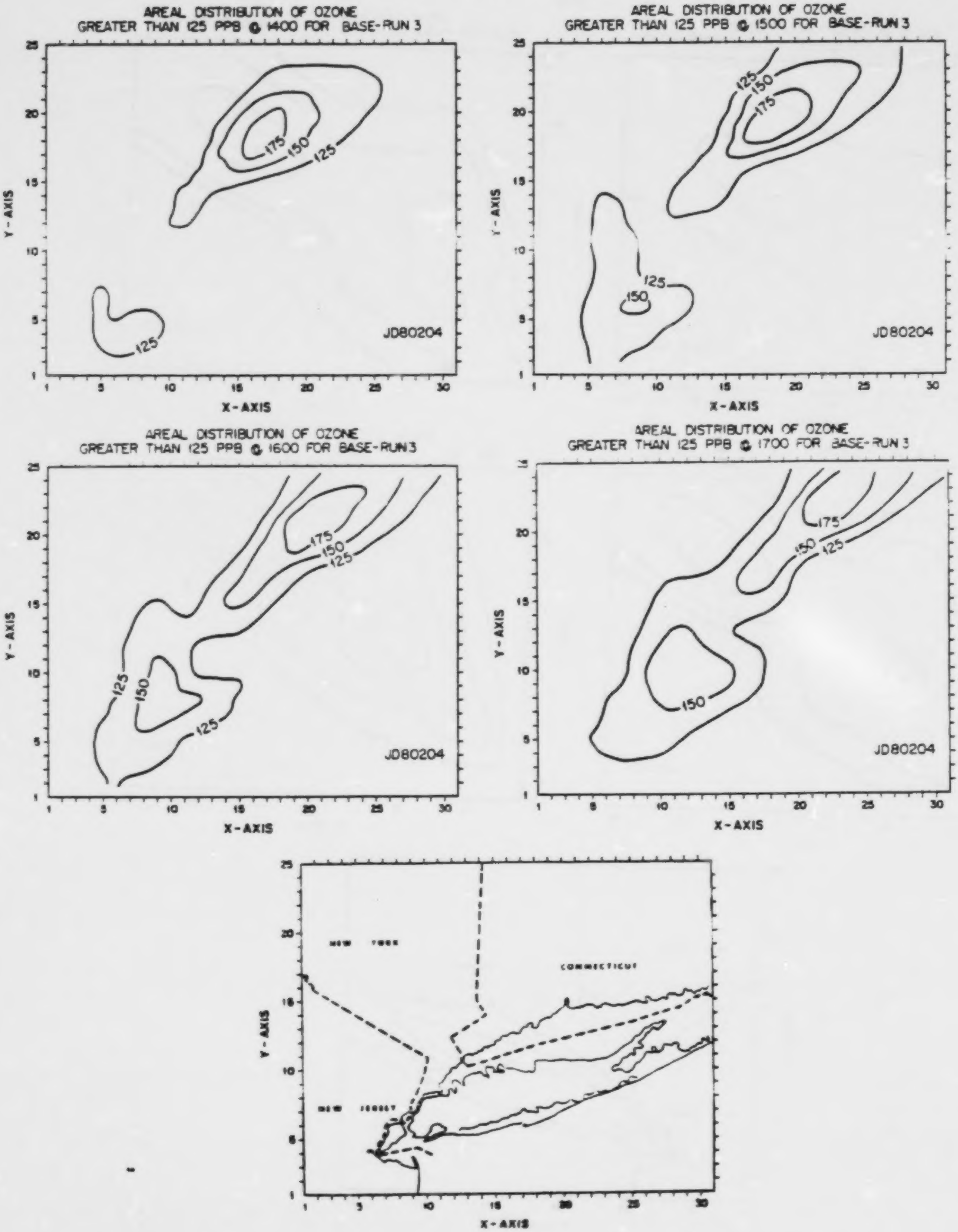


Figure 6.3 Areal Distribution of Ozone on JD80204(072280) from 1400 to 1700 Hrs.

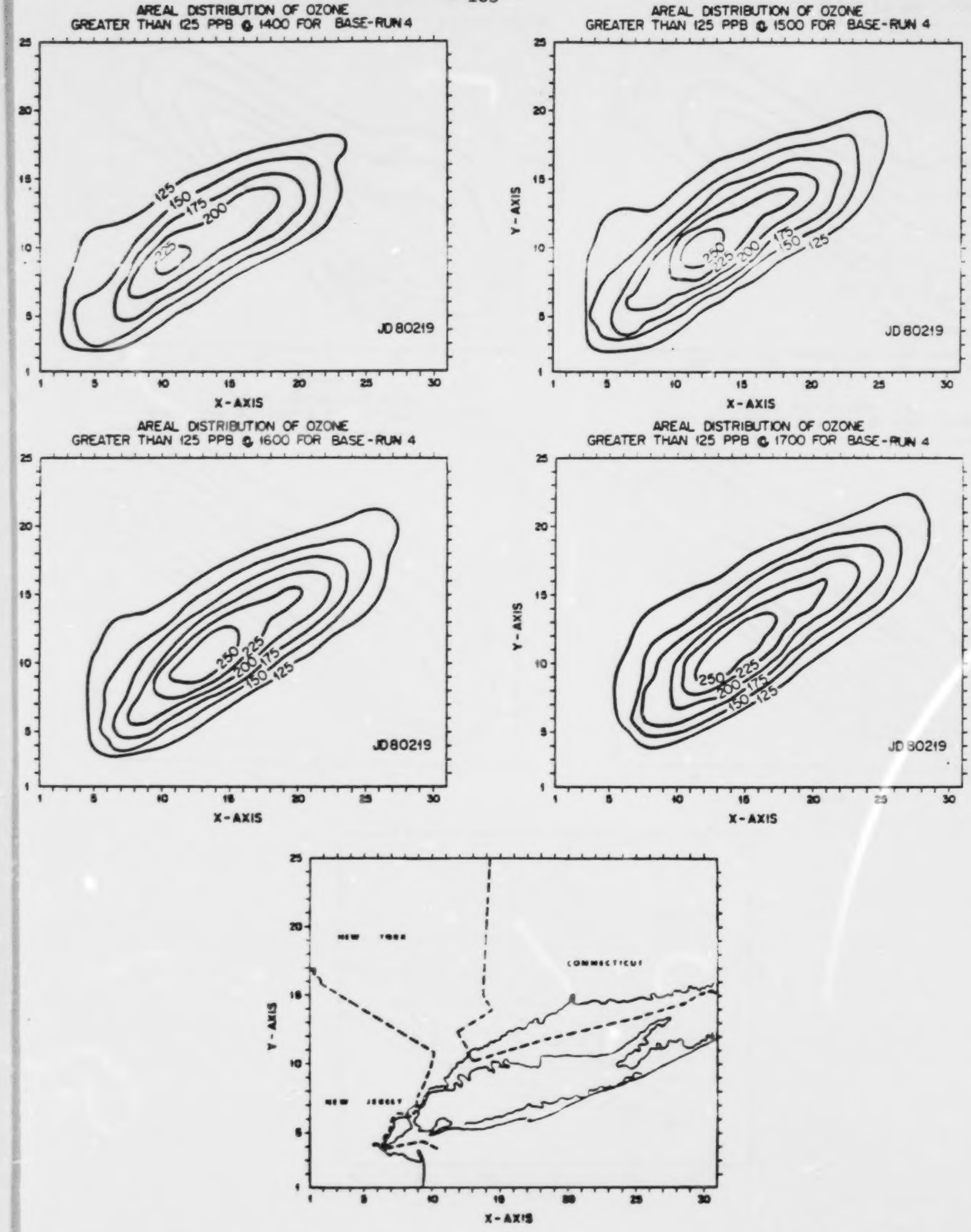
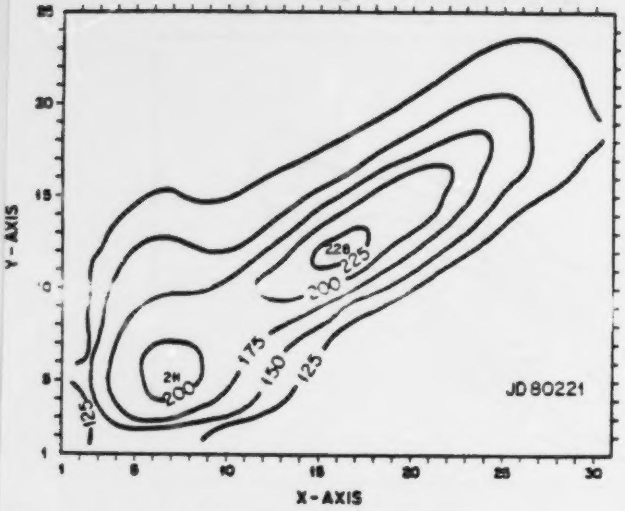
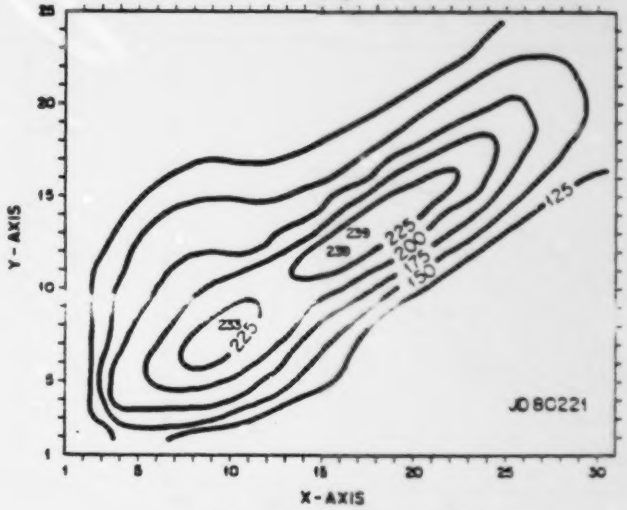


Figure 6.4 Areal Distribution of Ozone on JD80219(080680) from 1400 to 1700 Hrs.

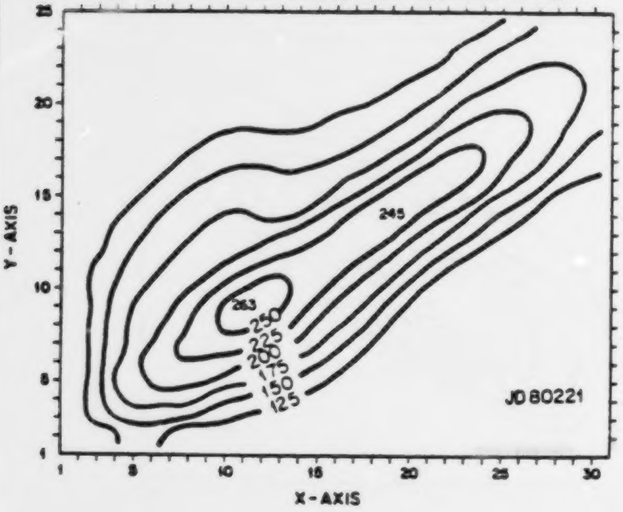
AREAL DISTRIBUTION OF OZONE
GREATER THAN 125 PPB @ 1400 FOR BASE-RUN 5



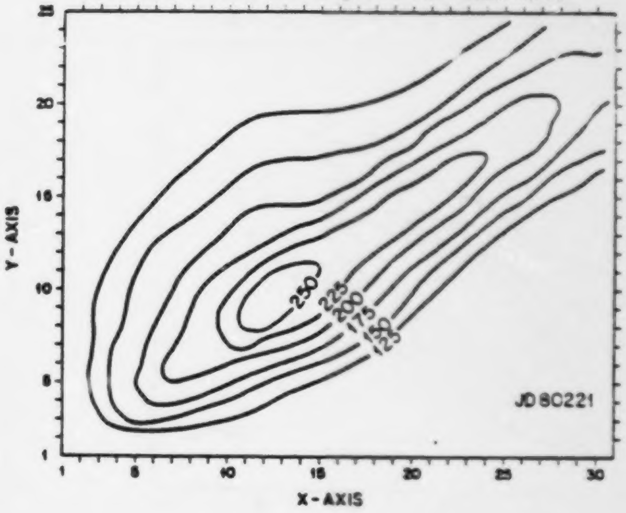
AREAL DISTRIBUTION OF OZONE
GREATER THAN 125 PPB @ 1500 FOR BASE-RUN 5



AREAL DISTRIBUTION OF OZONE
GREATER THAN 125 PPB @ 1600 FOR BASE-RUN 5



AREAL DISTRIBUTION OF OZONE
GREATER THAN 125 PPB @ 1700 FOR BASE-RUN 5



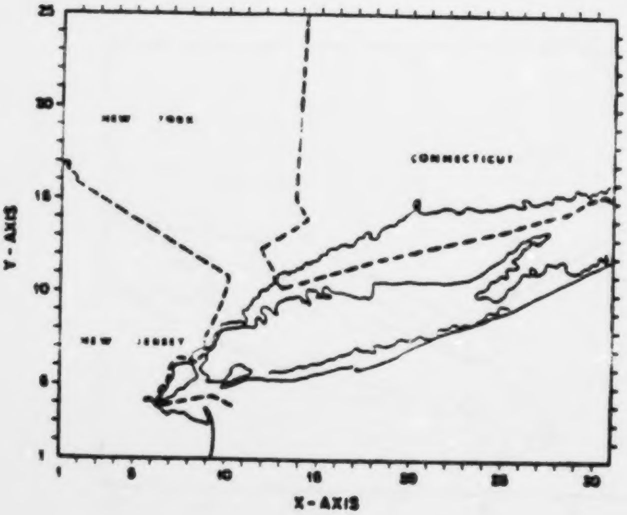

Y-AXIS
X-AXIS
1
5
10
15
20
25
30
NEW YORK
CONNECTICUT
NEW JERSEY

Figure 6.5 Areal Distribution of Ozone on JD80221(080880) from 1400 to 1700 Hrs.

from the monitoring station. Diurnal plots of the observed and predicted concentrations at the monitoring stations are presented in Appendix B. Several standard statistical measures (Willmott, 1981; Fox, 1981; Rao, et al., 1985) are computed, and the results are listed in Table 6.1. The high correlation coefficients ($r_{crit.95} \geq 0.098$) indicate that the model predictions are reasonable either when the data are considered on an individual day-by-day basis or on an ensemble basis. However, on an overall basis, the model overpredicts the concentrations by about a factor of two as indicated by the mean of ratios of predicted to the observed concentrations. Of the five days, the two that show the highest correlation coefficient and index of agreement are JD80203(072180) and JD80221(080880).

A scatter plot of the observed and predicted concentrations for all data for each of the days considered is shown in Figure 6.6. In addition to the one-to-one line (perfect prediction), an envelope of ±30% of the observed concentrations is shown in the figure by dashed lines. The percentage number of points lying within ±30%, greater than 30%, and less than 30% are provided in Table 6.2. The percentage of data within the ±30% envelope for each of the days is about 30% or better, while the percentage of underprediction is about 10%.

Figure 6.7 is a histogram of the difference between the measured and predicted concentrations for each of the simulation days. The percentage of data falling within ±0.03 ppm ranges from 45 to 51% depending upon the simulation day, with the majority of the remaining data generally in the overprediction category (OBS-PRED < -0.03 ppm). The exception for this is the performance on JD80204(072280), (see Figure 6.7) for which about 27% of the data are in the overprediction category. However, examination of the model performance measures listed in Table 6.1 for this day indicates that its slope and correlation coefficient are slightly lower in comparison with other days.

For each of the simulation days, the diurnal variation of the mean difference between the observed and the predicted concentrations along with the standard deviation of the difference is shown in Figure 6.8. It is interesting to note that up to about 1300 Hrs the difference is confined to ±0.03 ppm, and for the remaining hours of simulation the mean differences exceed 0.05 ppm, indicating an overprediction by the model. Also, the error spread in the afternoon hours is considerably larger than during the morning hours for each of the days.

TABLE 6.1

Summary of Paired Comparison of Ozone Concentrations for All Data (ppm)

	JD80198 (071680)		JD80203 (072180)		JD80204 (072280)		JD80219 (080680)		JD80221 (080880)		ALL DATA	
	OBS	PRED	OBS	PRED	OBS	PRED	OBS	PRED	OBS	PRED	OBS	PRED
Range	.000 to .291	.000 to .266	.000 to .303	.000 to .228	.000 to .240	.000 to .183	.000 to .249	.000 to .262	.000 to .246	.000 to .263	.000 to .303	.000 to .266
Mean	.072	.103	.084	.108	.060	.081	.060	.105	.070	.117	.069	.103
Standard Deviation	.059	.066	.055	.058	.045	.045	.047	.068	.045	.073	.051	.063
Correlation Coefficient	.466		.760		.560		.571		.759		.600	
Slope	.514		.794		.562		.827		1.180		.744	
Intercept	.066		.042		.048		.055		.035		.051	
Mean of (P/O)	2.413		1.785		2.070		3.079		2.057		2.277	
Std. Dev. of (P/O)	3.129		2.438		3.122		7.084		2.392		4.050	
Mean Diff. (O -P)	-.031		-.024		-.021		-.045		-.047		-.034	
Std. Dev. of (O -P)	.065		.039		.042		.056		.049		.052	
Avg. Abs. Gross Error	.051		.036		.037		.052		.050		.045	
Root Mean Square Error for the Difference (RMSE)	.072		.046		.047		.072		.068		.062	
Index of Agreement	.638		.828		.698		.630		.692		.701	
Mean Fractional Error (MFE)	-.107		-.078		-.084		-.146		-.138		-.111	
MSEu	.003		.001		.001		.003		.002		.002	
MSEs	.002		.001		.001		.002		.002		.001	
MSEu/MSE (%)	65		66		62		60		51		66	
MSEs/MSE (%)	35		34		38		40		49		34	
Sample Size	418		432		422		422		408		2101	

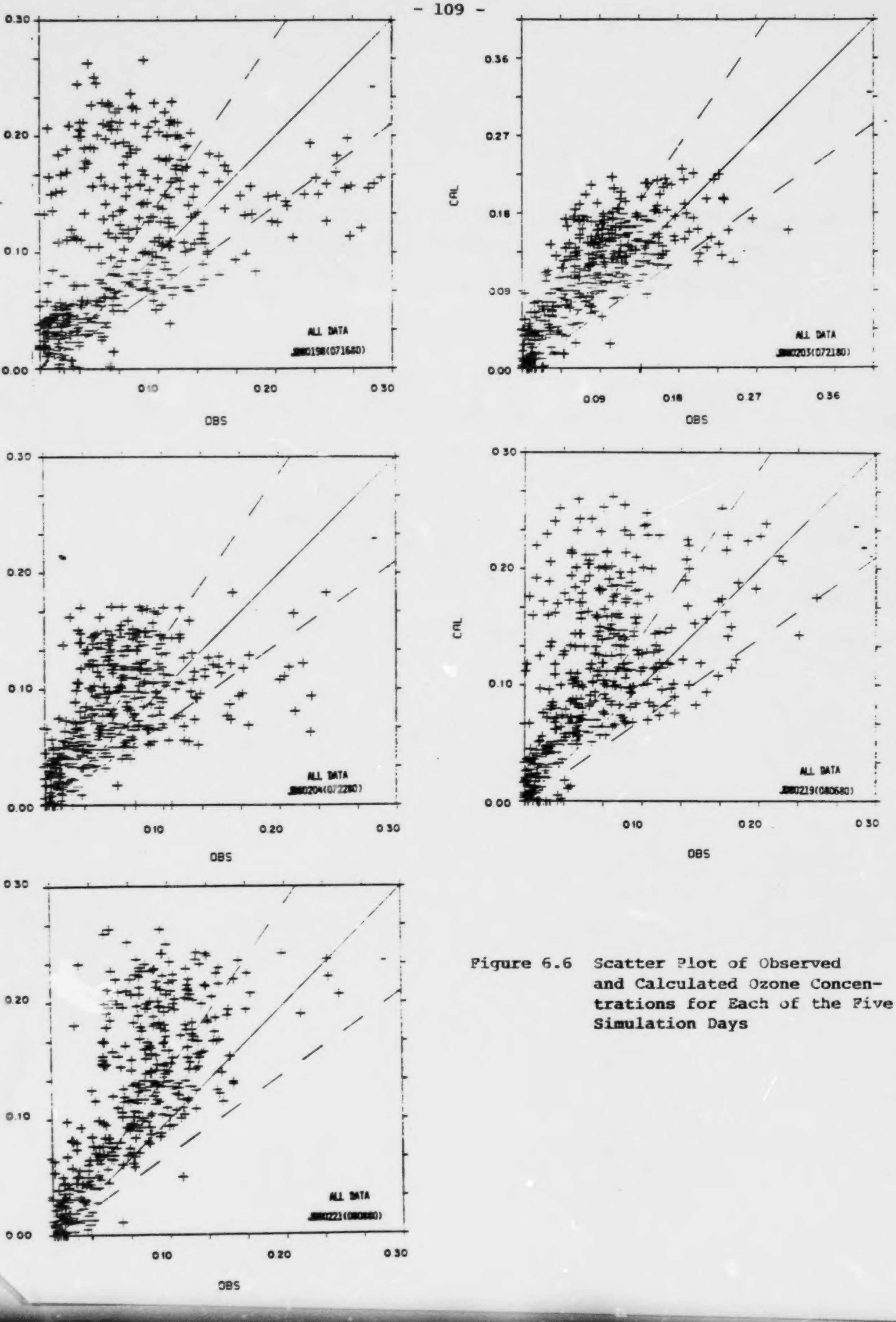


Figure 6.6 Scatter Plot of Observed and Calculated Ozone Concentrations for Each of the Five Simulation Days

TABLE 6.2

Percent of Model Predictions Within ±30%, Greater Than 30%, and Less Than 30% of their Corresponding Measured Ozone Concentrations for the Five Selected Days

Category	JD80198 (071680)	JD80203 (072180)	JD80204 (072280)	JD80219 (080680)	JD80221 (080880)	All Data
	Day					
Percentage Within ±30%	34	46	35	30	33	36
Percentage of Over Prediction	53	44	53	62	60	54
Percentage of Under Prediction	13	10	12	8	7	10
Sample Size	418	432	422	422	408	2102

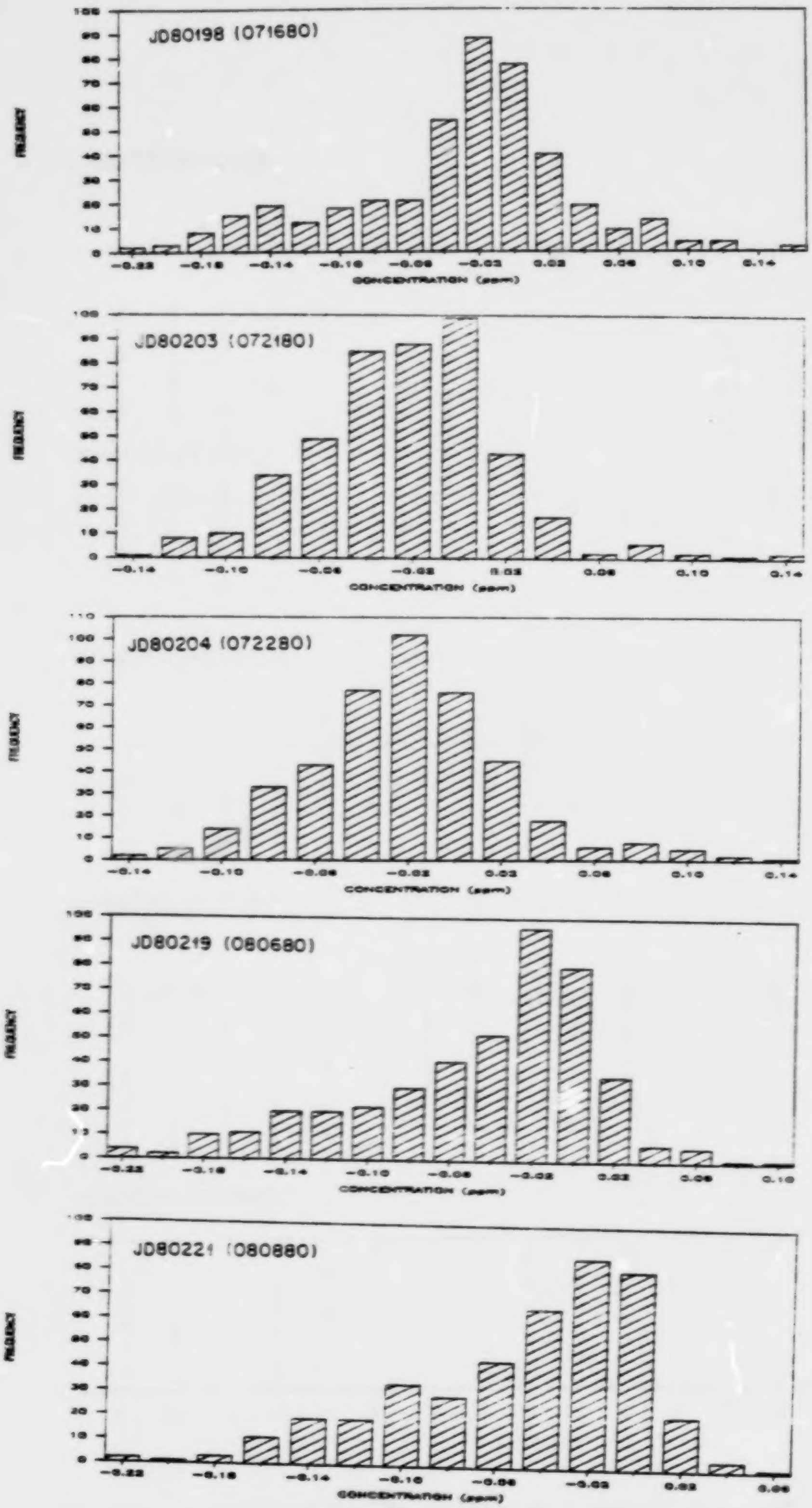


Figure 6.7 Histogram of (OBS-PRED) Concentrations (PPM) for each of the Five Simulation Days

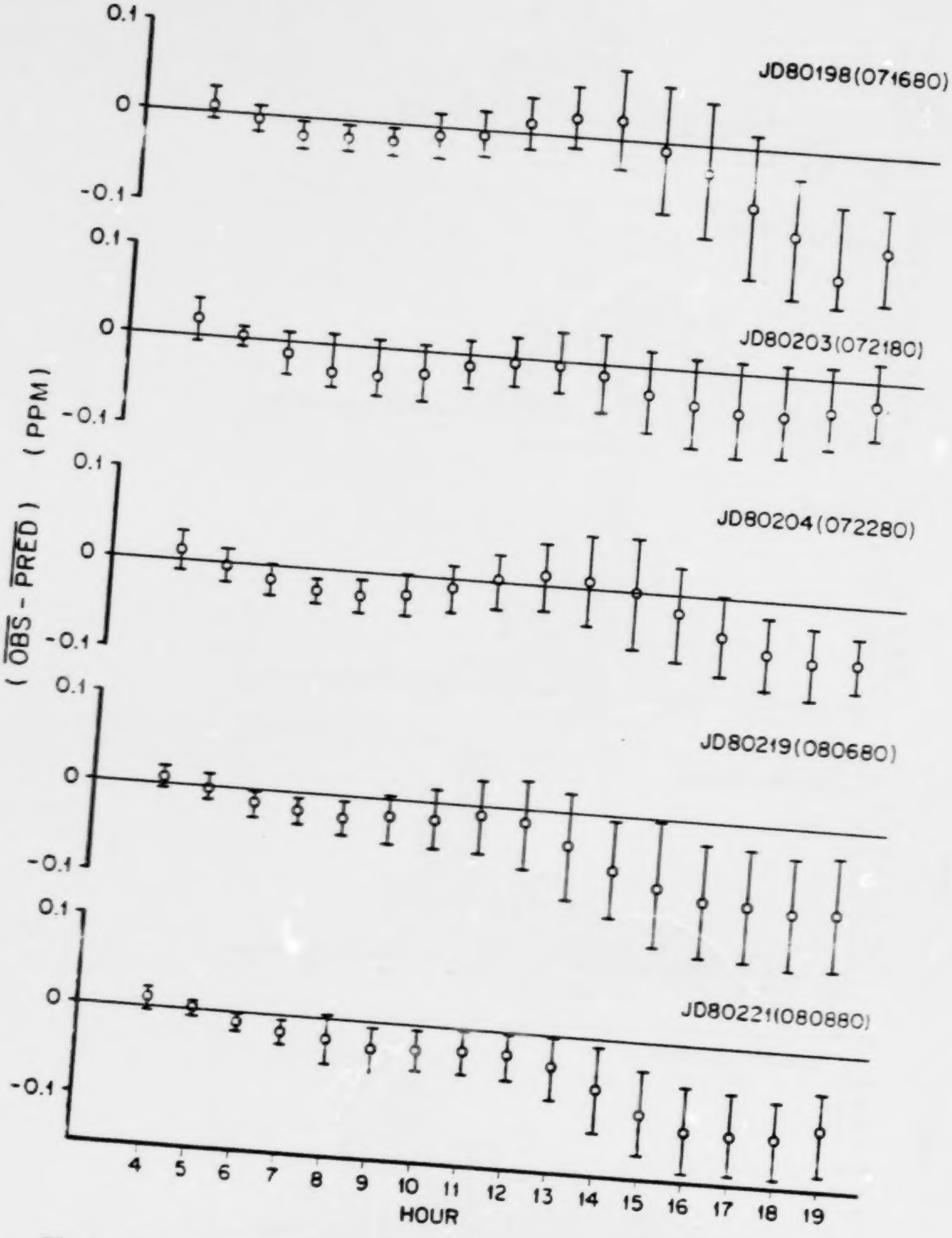


Figure 6.8 Mean and Standard Deviation of the Difference between the Observed and Predicted Concentrations as a Function of Time

6.2.1 Paired Comparison - Data from Connecticut

Since the measured ozone measurements for the five days indicate that the peak concentrations occur over the Connecticut region, assessment of the model performance in this region would be of particular interest. Figure 6.9 is a scatter plot of observed and predicted concentrations along with the ±30% envelope. In Table 6.3, the percentages of points within, below and above the ±30% envelope for each simulation day as well as the ensemble are listed. The percentage of underprediction is about 10%, with about 50% of the data lying in the ±30% envelope. In terms of the model performance, the day JD80203(072180) has 60% of its predictions within the ±30% envelope followed by JD80221(080880) with 50%, and in both cases about 9% or less of the data are in the underprediction category.

6.2.2 Paired Comparison - Concentrations Greater Than 100 ppb

It is important to analyze the model performance in simulating high ozone concentrations in order to provide an assessment of the model's ability to capture the peak concentration values. Toward this end, any hourly measured concentration greater than or equal to 100 ppb and its corresponding predicted value were examined as a set for (a) the domain as a whole, (b) the Connecticut region alone, and (c) New York and New Jersey. Scatter plots of the observed and predicted concentration for each of the five days are shown in Figures 6.10 and 6.11 for the latter two cases, respectively. The percentage of points lying within, above and below the ±30% envelope are listed in Tables 6.4a, 6.4b, and 6.4c for the entire domain, Connecticut, and New York and New Jersey, respectively. The model appears to perform quite well, with at least 60% of the predictions lying within the ±30% envelope in all the three cases and about 20% of the data on either side of the envelope. However, when measured concentrations greater than or equal to 200 ppb and the corresponding predictions are considered for the Connecticut region, the model underpredicts with an average predicted-to-measured ratio of 0.73. In Figure 6.12, the mean difference between the observed and predicted concentrations and the standard deviation of the differences are shown by the time of the day for each of the

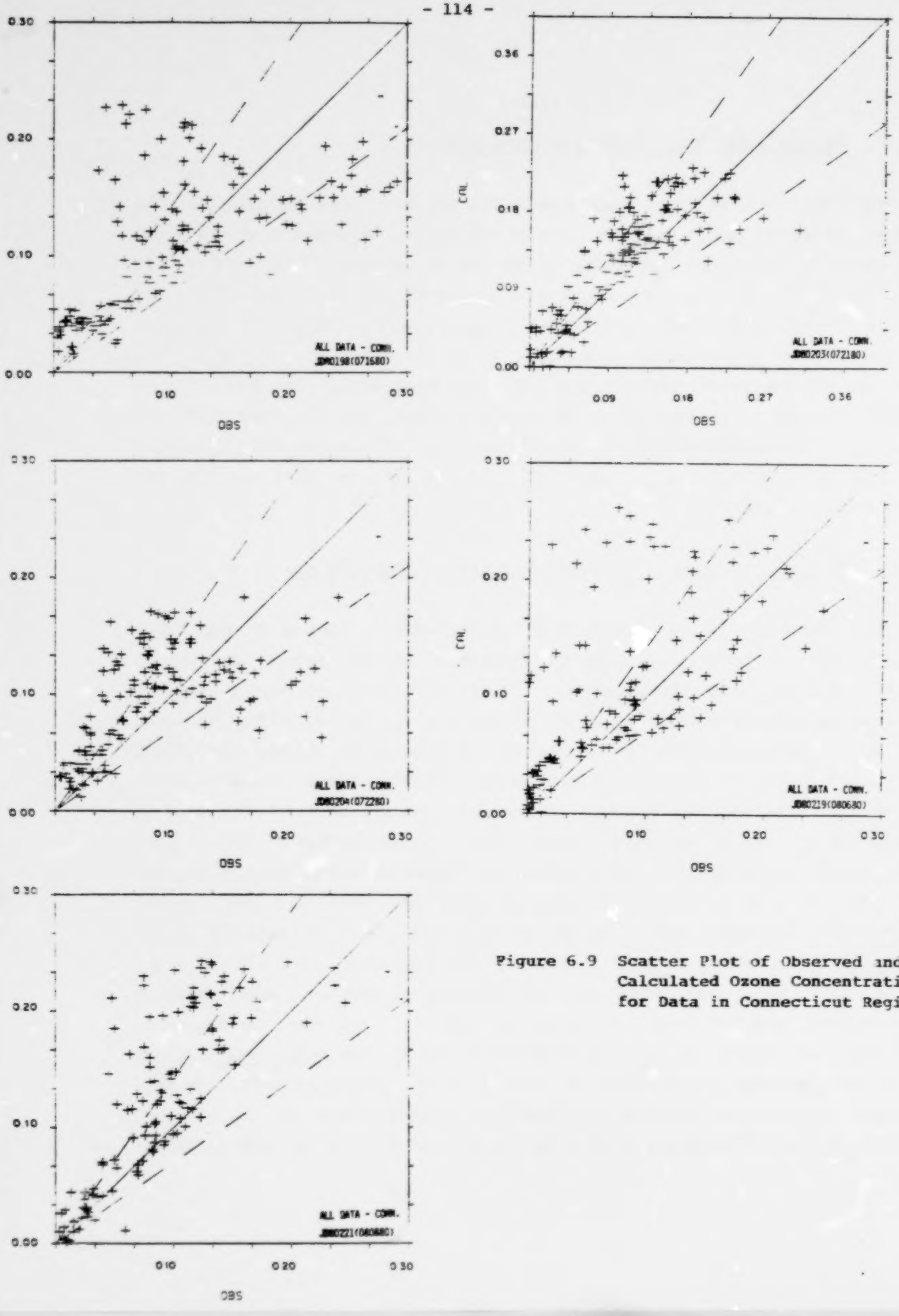


Figure 6.9 Scatter Plot of Observed and Calculated Ozone Concentrations for Data in Connecticut Region

TABLE 6.3

Percent of Model Predictions Within ±30%, Greater Than 30%, and Less Than 30% of their Corresponding Measured Ozone Concentrations for Connecticut

	Day					
Category	JD80198 (071680)	JD80203 (072180)	JD80204 (072280)	JD80219 (080680)	JD80221 (080880)	All Data
Percentage Within ±30%	49	64	46	43	50	51
Percentage of Over Prediction	35	27	42	48	44	39
Percentage of Under Prediction	16	9	12	9	6	10
Sample Size	142	140	139	127	125	673

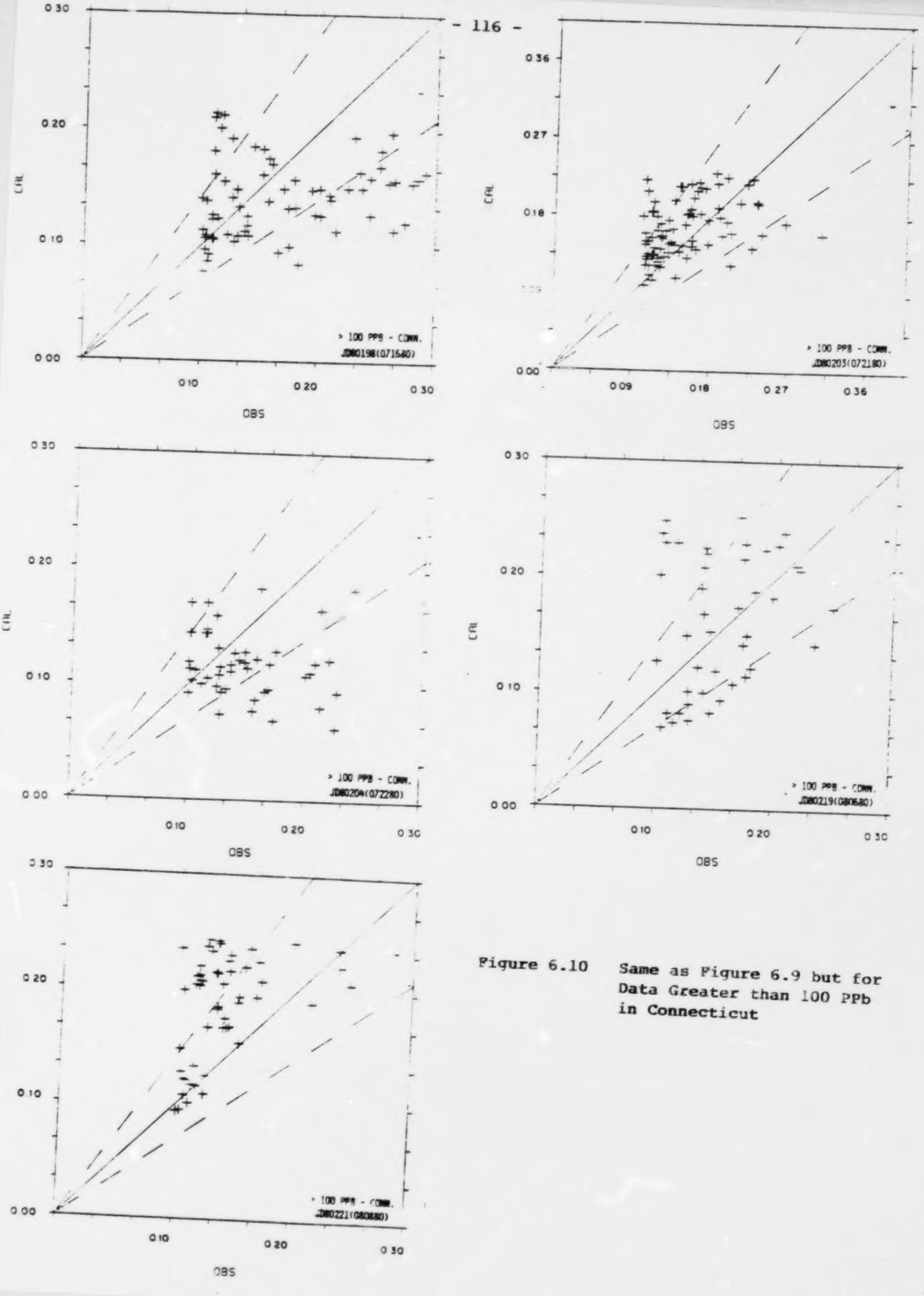
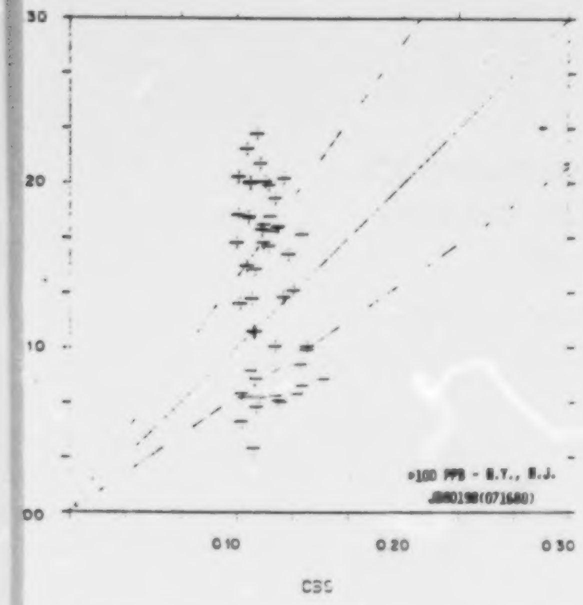
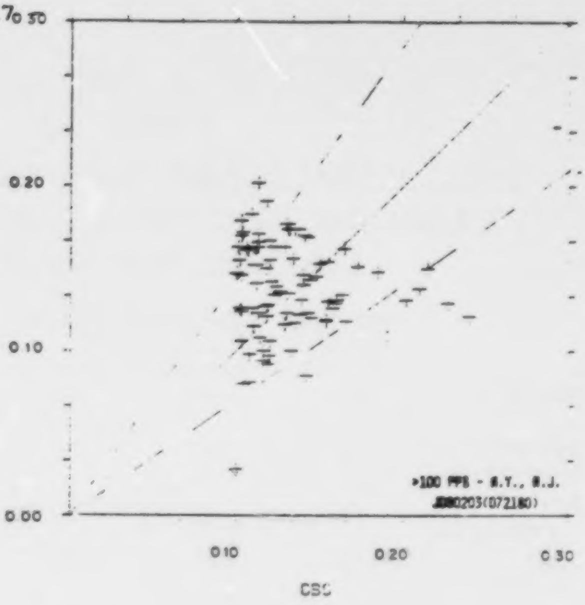
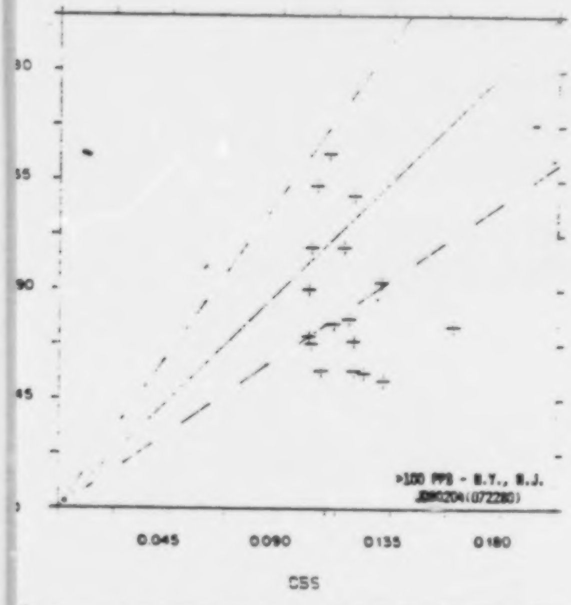
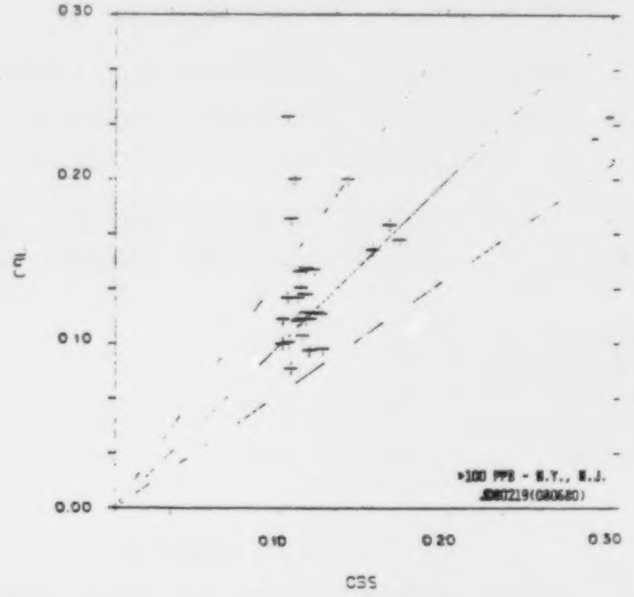


Figure 6.10 Same as Figure 6.9 but for Data Greater than 100 PPb in Connecticut









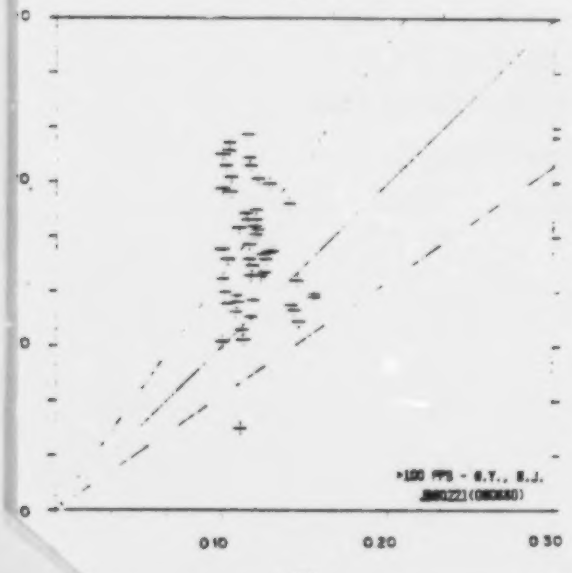


Figure 6.11 Same as in Figure 6.9 but for Data Greater than 100 PPb in New York and New Jersey

TABLE 6.4a

Percent of Model Predictions Within ±30%, Greater Than 30%, and Less Than 30% of their Corresponding Measured Ozone Concentrations Greater than 100 ppb

	Day					
Category	JD80198 (071680)	JD80203 (072180)	JD80204 (072280)	JD80219 (080680)	JD80221 (080880)	All Data
Percentage Within ±30%	50	76	60	69	60	64
Percentage of Over Prediction	20	17	3	17	40	21
Percentage of Under Prediction	30	7	37	14	-	15
Sample Size	118	164	63	70	100	515

TABLE 6.4b

Percent of Model Predictions Within ±30%, Greater Than 30%, and Less Than 30% of their Corresponding Measured Ozone Concentrations Greater than 100 ppb for Connecticut

	Day					
Category	JD80198 (071680)	JD80203 (072180)	JD80204 (072280)	JD80219 (080680)	JD80221 (080880)	All Data
Percentage Within ±30%	59	80	65	56	60	66
Percentage of Over Prediction	10	14	4	21	40	17
Percentage of Under Prediction	31	6	31	23	-	17
Sample Size	68	84	46	43	52	293

TABLE 6.4c

Percent of Model Predictions Within ±30%, Greater Than 30%, and Less Than 30% of their Corresponding Measured Ozone Concentrations Greater than 100 ppb For New Jersey and New York

	Day					
Category	JD80198 (071680)	JD80203 (072180)	JD80204 (072280)	JD80219 (080680)	JD80221 (080880)	All Data
Percentage Within ±30%	39	70	38	85	61	60
Percentage of Over Prediction	31	21	0	9	39	24
Percentage of Under Prediction	30	9	62	6	-	16
Sample Size	50	80	17	27	48	222

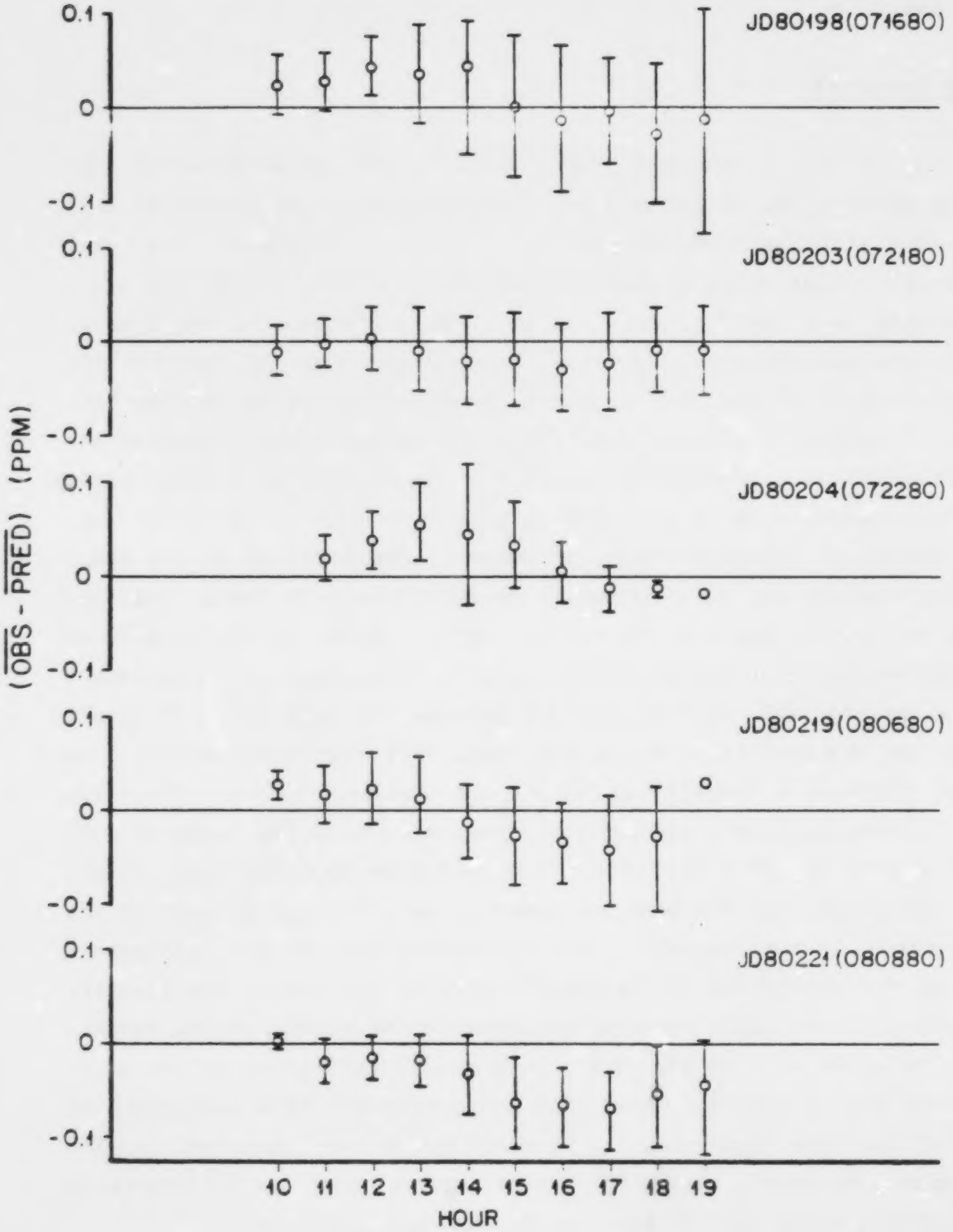


Figure 6.12 Same as Figure 6.8 but for the Observed Concentrations Greater than 0.10 ppm and their Corresponding Predicted Concentrations

five days over the domain when measured concentrations exceed 100 ppb. The systematic bias evident when all data are considered (see Figure 6.8) is absent in this case, and the mean differences between the observed and predicted are within ±0.05 ppm.

6.3 Unpaired Comparison

Another way to assess the model performance is through an unpaired comparison of the daily maxima of the measured and predicted concentrations at each of the monitoring stations independent of their time of occurrence. The ratio between the predicted and measured peaks ranges from 1.29 to 1.72 for the ozone monitoring network over the tri-state region. The difference in the time of occurrence of the measured and predicted peaks ranges from ±2 Hrs for the New Jersey stations to ±5 Hrs for locations in Connecticut with the New York sites falling in between. A similar analysis of the second highest measured and second highest predicted concentrations at each of the monitoring stations yields a ratio in the range of 1.36 to 1.82 with a time difference of ±2 to ±5 Hrs. However, it should be recognized that, in general, the location of the model predicted ozone maximum may not necessarily be associated with those locations where ambient air quality measurements are available. Hence, for the purpose of comparison, the maximum measured and predicted ozone concentrations (independent of time and space) for all the five days are provided in Table 6.5. It should be noted that the measured ozone maxima for these five days are reported from the monitoring stations in Connecticut, as are the predicted values. The ratio of predicted to measured hourly maximum concentrations are in the range of 0.70 to 1.00 with a time lag of 0 to 3 Hrs. This indicates that the model underpredicts the peak value over the modeling domain as well as lags in terms of the time of occurrence of the maximum. This discrepancy may be due to numerous factors such as the uncertainty in the specification of the initial and boundary pollutant concentrations, space and time variation in the adopted mixing height, and the wind fields as well as the lack of day-to-day variations in the emissions data. It should also be noted that meteorological data summarized in Table 2.4 indicate the occurrence of precipitation over portions of the simulation region, presumably resulting in some scavenging of the pollutants in the real atmosphere, while the UAM does not include such processes.

TABLE 6.5

Base Case Simulations: Unpaired Spatially and Temporally

		Concentration (ppb)				
		Measured[+]		Predicted[++]		
Run	Date	Max	Hr	Max	Hr	Ratio
1	JD80198(071680)	291	14-15	205	17-18	0.70
2	JD80203(072180)	303	15-16	229	15-16	0.76
3	JD80204(072280)	240	16-17	191	16-17	0.79
4	JD80219(080680)	249	13-14	229*	15-16	0.92
5	JD80221(080880)	246	13-14	246	16-17	1.00

[+] Measured at any monitor in the Connecticut Region
[++] Predicted at any grid in the Connecticut Region

6.4 Model Performance - Summary

The results from the above analysis suggest that the model has performed reasonably well with about 60% of the predictions in the ±30% envelope about the perfect prediction line when measured concentrations are greater than 100 ppb. Both temporal and spatial comparisons of the measured and predicted concentrations indicate that the UAM overpredicts on the average. However, the model is found to underpredict for the subset comprised of measured concentrations greater than or equal to 200 ppb. The model performance for the days JD80203(072180) and JD80221(080880) is, in general, better than the other three days with a tendency to underpredict the peak concentrations. Simulation studies conducted for Tulsa (Reynolds, et al., 1982), St. Louis (Cole, et al., 1983), and Philadelphia (Haney and Braverman, 1985) using the UAM have reported similar results. The fact that the model does not reproduce the measured maximum concentrations in the modeling domain should not deter its application in emissions control strategy evaluations, as long as the estimated ozone concentrations due to the imposition of specific controls are assessed in a relative sense.

6.5 Modeling Limitations

It is well known that several sources of uncertainty exist in air quality modeling that could affect the predicted concentrations of the pollutants. These uncertainties can be broadly categorized as "reducible" and "inherent" uncertainties. Errors in the input data to the model as well as inadequate formulation of the physical and chemical processes in the model lead to reducible uncertainty since uncertainties associated with these can be minimized through more accurate input data as well as improved model formulation. Inherent uncertainty stems from the stochastic nature of the atmosphere. No matter how perfect the model and the input data are, the imprecision cannot be reduced below a fundamental level because of the lack of predictability of the transport and diffusion processes in the atmosphere. Therefore, the model estimates will almost always differ from the measured concentrations. However, an understanding of the input uncertainty arising from errors in measurements, errors in estimation, non-representativeness of the data, etc., will enable proper interpretation of the modeling results.

As mentioned before, the the numerical modeling approach adopted here is data-intensive. It should be recognized that errors stemming from sparsity of available data and the approximations used to generate information at each grid point for each variable will propagate through the model and affect the predicted concentrations. Quantification of the modeling uncertainty due to the uncertainty in the input data alone is an extremely difficult non-linear problem. No attempts are made in this report to quantify the UAM limitations or uncertainties associated with the UAM application to the New York Metropolitan area because of the complexity of the problem. Evaluation of the modeling uncertainty is beyond the scope of this study.

CHAPTER 7

CONTROL STRATEGY SIMULATIONS

One of the primary objectives of this study was to evaluate whether selected control strategies on the precursor emissions would lead to the attainment of the NAAQS for ozone in the New York Metropolitan area. To this end, the UAM has been applied for five high ozone days occurring in the 1980 ozone season. Evaluation of the model performance in predicting the measured ozone levels revealed best performance of the model on two days - JD80203(072180) and JD80221(080880). Hence, these days were selected for assessing the impact of emissions control strategies on the ambient ozone concentrations. An emissions inventory based upon the 1982 State Implementation Plans (SIPs) for 1988 was prepared and the UAM simulation was performed for these two days with appropriate modifications to the initial and boundary air quality conditions, keeping the meteorological conditions the same as those for the 1980 base year cases. In this section, the results of the various control strategy scenarios are presented and are compared with the base case(s) to evaluate the effect of emissions reduction plans on the ambient ozone concentrations in the study region.

7.1 Initial and Boundary Conditions

The methodology adopted for defining the initial and boundary conditions for the control strategy simulations was as follows. For the initial conditions, a comparison was made between the projected 1988 NO_x and VOC emissions and those of the 1980 base case, and the percentage reductions for these two pollutants were calculated. These emissions reductions were then applied to scale the base year initial NO_x and VOC concentration fields from the surface up to the top of vertical layer 3 (through the mixed layer), under the assumption that the changes in the precursor emissions have a similar effect on the ambient concentration fields. The 1988 VOC and NO_x concentrations at the boundaries were obtained by reducing the base year boundary concentrations of VOC and NO_x by 40% and 20%, respectively, based upon the upwind region SIPs.

In the case of ozone, no direct methods are available to estimate the future year boundary and initial fields due to the changes in the precursor

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emissions levels. Given that the ozone concentrations at the top of the modeling region for the five simulated days in the base year are in the range of 60 to 85 ppb, the proposed changes in the emissions both upwind and in the domain could result in a reduction of about 20 to 30% or in the 40 to 60 ppb range for ozone levels at the top of the modeling domain. These estimates are consistent with the suggested background levels (Wolff and Lioy. 1978; Kelly, et. al., 1984). Another method is to apply the EKMA procedure (EPA, 1984) to estimate the expected changes in the ozone concentrations from changes in the VOC and NO_x levels. This procedure, results in a reduction of about 18% in ozone for an assumed change in the VOC and NO_x levels of 40% and 20%, respectively. In this study, as a first approximation, a 20% reduction from the ambient 1980 ozone levels was adopted for estimating the 1988 ozone concentrations for the region top and the initial and boundary fields. As an example of the 1988 boundary conditions, the changes in the NMHC and ozone concentrations for the southwest corner surface grid cell for the two days JD80203(072180) and JD80221(080880), are shown in Figure 7.1a and 7.1b, respectively.

7.2 Control Strategies

A set of six control strategy scenario simulations (CSSS), listed in Table 7.1, was performed to evaluate five control strategies proposed by the project (OMNYMAP) Policy and Technical Committees with three of the five strategies utilizing measures implemented and/or proposed in the current SIPs of the three states. The CSSS Runs 1 and 2 are based upon the projected 1988 emissions with the meteorological conditions prevailing on the days JD80203(072180) and JD80221(080880), respectively. The changes in the emissions resulting from the various control strategies are listed in Table 7.2. In the case of CSSS Runs 1 and 2, the reductions in VOC and NO_x emissions from the 1980 base year are 32% and 14%, respectively, while with implementation of the full SIP measures (CSSS Run 6), the reductions in the VOC's are estimated to be an additional 8% over the CSSS Run 1 case in the tri-state area. It should be noted that these changes in VOC and NO_x emissions are not uniform or across-the-board reductions but vary from grid cell to grid cell. The CSSS Runs 4,5, and 6 utilized the JD80203(072180) meteorological conditions but with the modified emissions while CSSS Run 3 was designed to investigate the effect on the ozone maximum due to the reduction of Connecticut VOC emissions from the base year 1980.

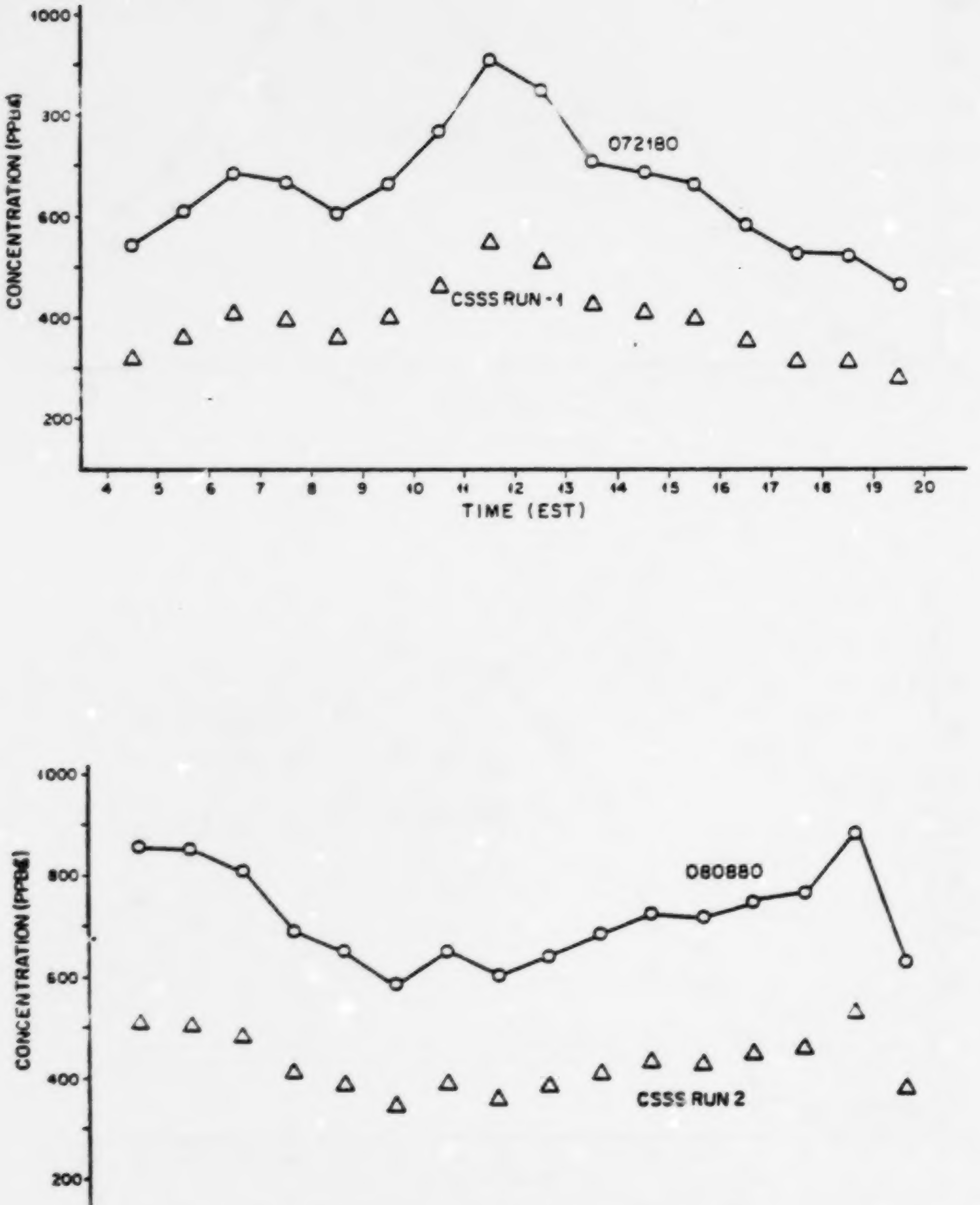


Figure 7.1a NMHC Concentrations at the Southwest Corner Grid for JD80203(072180) and JD80221(080880) for the Base Year and the Projected Year

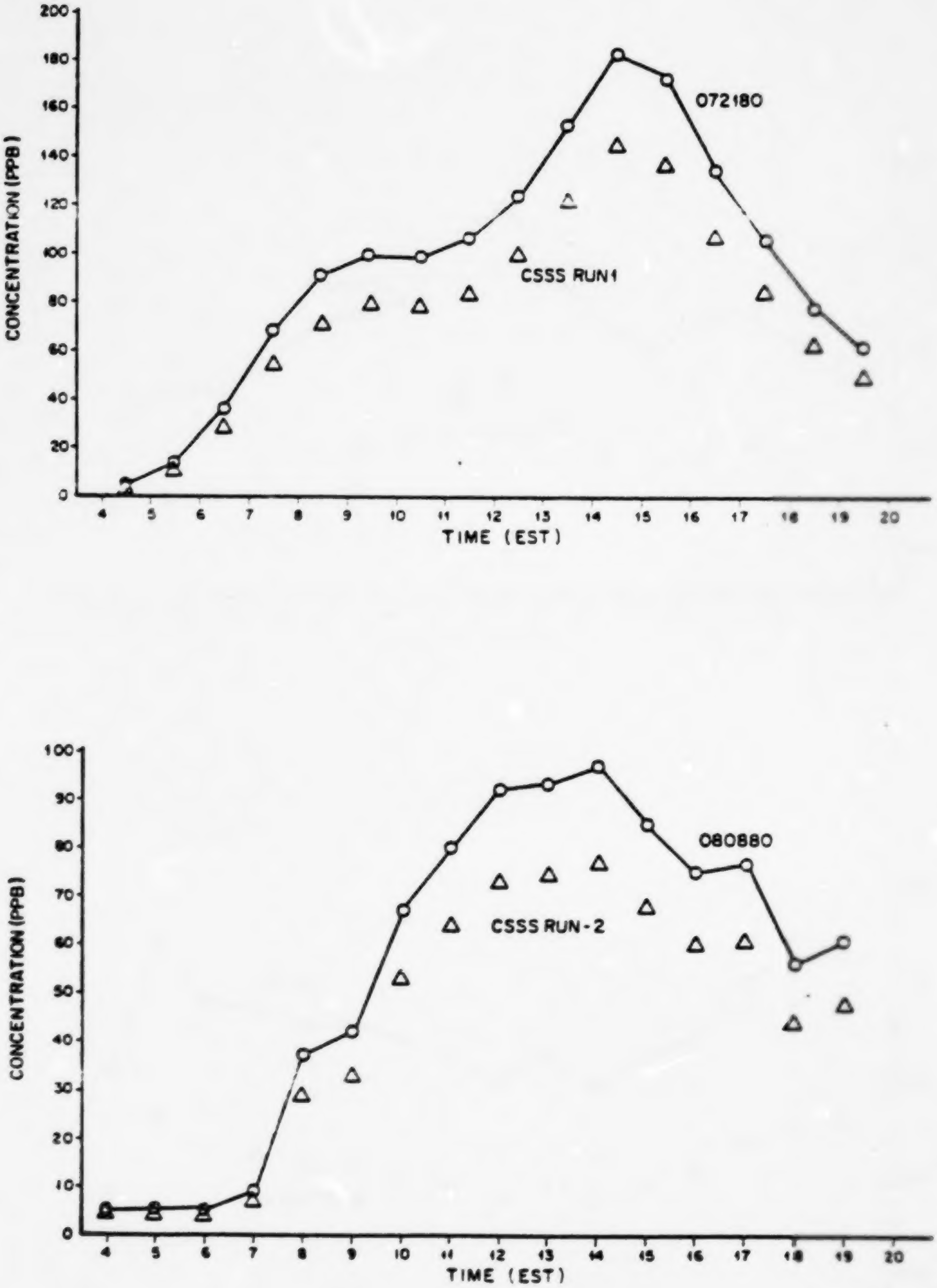


Figure 7.1b Ozone Concentrations at the Southwest Corner Grid for JD80203(072180) and JD80221(080880) for the Base Year and Projected Year

TABLE 7.1

Summary of Control Strategy Scenario Simulations (CSSS)

Run #1	Application of UAM using 1988 emissions inventory with JD80203(072180) meteorological conditions.
Run #2	Application of UAM using 1988 emissions inventory with JD80221(080880) meteorological conditions.
Run #3	Application of UAM with 1980 base year inventory excluding VOC emissions from Connecticut with JD80203(072180) meteorological conditions.
Run #4	Application of UAM using 1988 emissions inventory with 50% reduction in NO_x from all sources in Connecticut only and JD80203(072180) meteorological conditions.
Run #5	Application of UAM using 1988 emissions inventory with controls on gasoline vapors (marketing and motor vehicle) and JD80203(072180) meteorological conditions.
Run #6	Application of UAM with full 1988 SIP (extraordinary measures) and JD80203(072180) meteorological conditions.

7.3 Results and Discussion

The spatial distributions of ozone for CSSS Runs 1 and 2 for the hours when peak concentrations are expected to occur are shown in Figure 7.2. For both days, the isopleths show the occurrence of a double peak similar to the base case although the peak value over the modeling domain has decreased from 229 ppb to 185 ppb for the JD80203(072180) case and from 245 ppb to 200 ppb for the JD80221(080880) case. The relative reduction in the peak concentration is approximately 19% in both cases for an emissions reduction of 32% in the VOC's and 14% in the NO_x over the modeling domain from the base year. The areal extent of the decrease in the level of ozone exceedances was examined by counting the number of cells equal to or exceeding the concentration of 125 ppb for each hour starting at 0900. This is shown as a histogram plot in Figure 7.3 both for the entire modeling domain (667 cells) as well as for the Connecticut region alone (208 cells). On a percentage basis for the peak ozone hour of 1500, the decrease in the number of cells (areal extent) is about 50% for JD80203(072180) compared with about 20% for the JD80221(080880) case for the entire domain as well as for the Connecticut region for the peak ozone hour of 1500. This may be due to the differences in the prevailing meteorological and initial/boundary conditions on these two days.

The runs, CSSS Run 5 and Run 6, are an extension of the control strategies to further reduce the 1988 emissions with the imposition of additional controls on gasoline vapors in New York and Connecticut (marketing and motor vehicles - CSSS Run 5) and the implementation of controls on (a)architecture coatings, (b)auto body refinishing, (c)consumer/commercial solvents, and (d) small source RACT (CSSS Run 6). Under the CSSS Run 5 scenario, the estimated reduction in the 1988 VOC emissions was an additional 2%, while for CSSS Run 6, the reduction was about 6% from the base 1988 emissions level (CSSS Run 1). To compare the effects of emissions reductions on ozone levels, the predicted concentration fields for CSSS Run 5 were subtracted from those of CSSS Run 1 for the hours of highest concentrations (1400 and 1500 Hrs) and are shown in Figure 7.4. The differences are of the order of 1 ppb over the Connecticut region which is essentially within the noise range and, therefore, the additional controls in New York and Connecticut arising from CSSS Run 5 have very little impact on the reduction of the ozone levels in the domain on this day.

TABLE 7.2

Summary of Emissions for Base Year and Control Strategy Scenarios (Tons)

Run	Scenario	New York		New Jersey		Connecticut		Modeling Domain	
		VOC	NO_x	VOC	NO_x	VOC	NO_x	VOC	NO_x
	BASE-1980	380,016	351,380	382,258	345,228	203,645	158,393	965,919	854,971
CSSS-1	Projection - 1988	241,193	292,149	272,802	324,339	140,291	122,369	654,286	738,857
	% Change from 1980	-36.5	-16.8	-28.6	-6.1	-31.1	-22.7	-32.3	-13.6
No VOC's at 50% from Conn.* CSSS-3		380,016	351,350	382,258	345,228	-	158,893	762,274	858,464
	% Change from 1980	-	-	-	-	-	-	-26.7	-
CSSS-4	No_x at 50% from Conn.**	241,193	292,149	272,802	324,339	140,291	61,185	654,286	677,673
	% Change from 1980	-	-16.8	-28.6	-6.1	-31.1	-61.4	-32.3	-21.1
CSSS-5	Stage II Controls	226,579	292,149	272,802	324,339	134,013	122,369	633,394	738,857
	% Change from 1980	-40.4	-16.8	-28.6	-6.1	-34.2	-22.7	-34.4	-13.6
CSSS-6	Full SIP Implement	199,163	292,149	255,780	324,339	123,706	122,369	578,649	738,857
	% Change from 1980	-47.6	-16.8	-33.1	-6.1	-39.3	-22.7	-40.1	-13.6

*1980 Emissions
**1988 Emissions

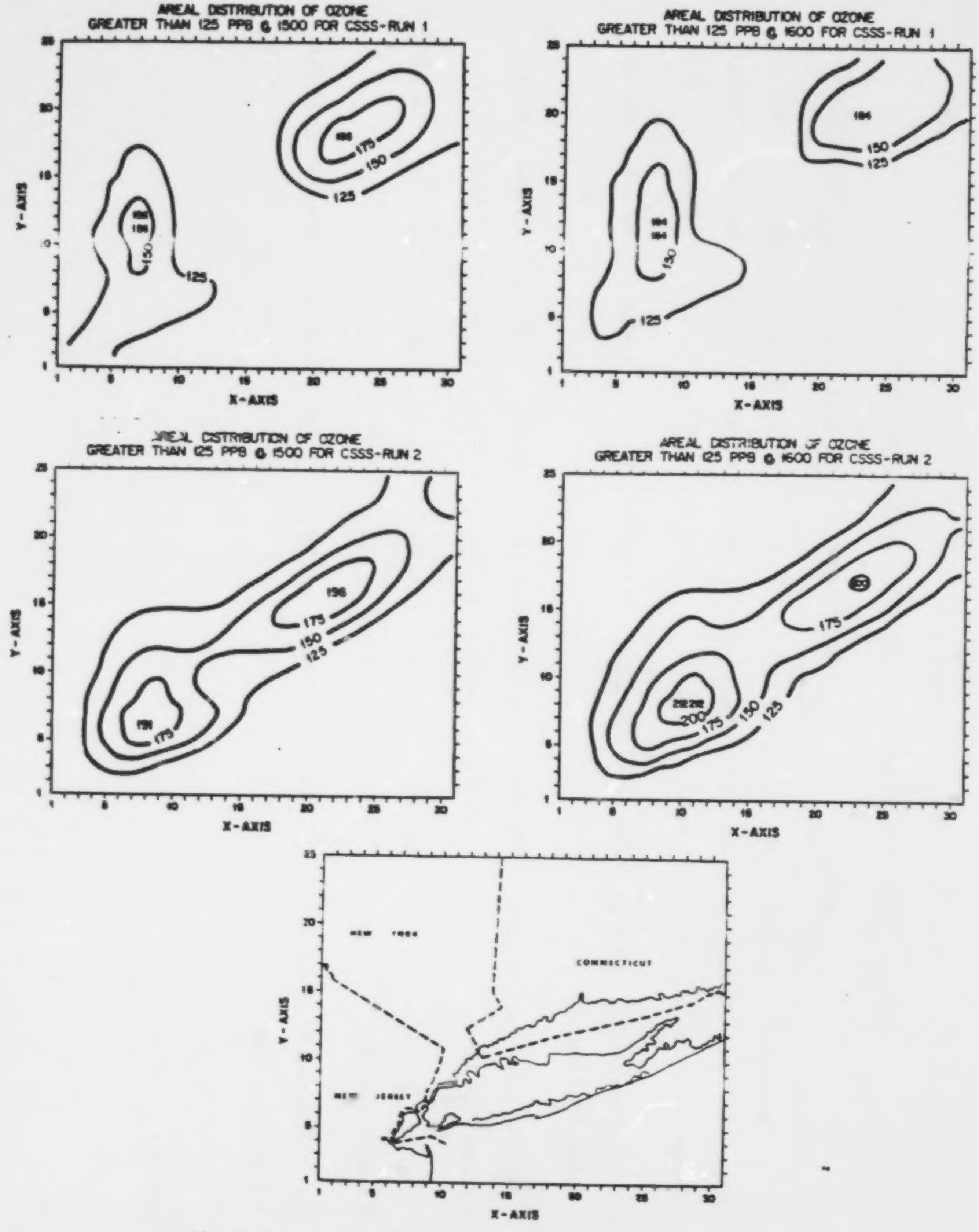


Figure 7.2 Spatial Distribution of Ozone for Selected Hours for CSSS Run 1 and CSSS Run 2

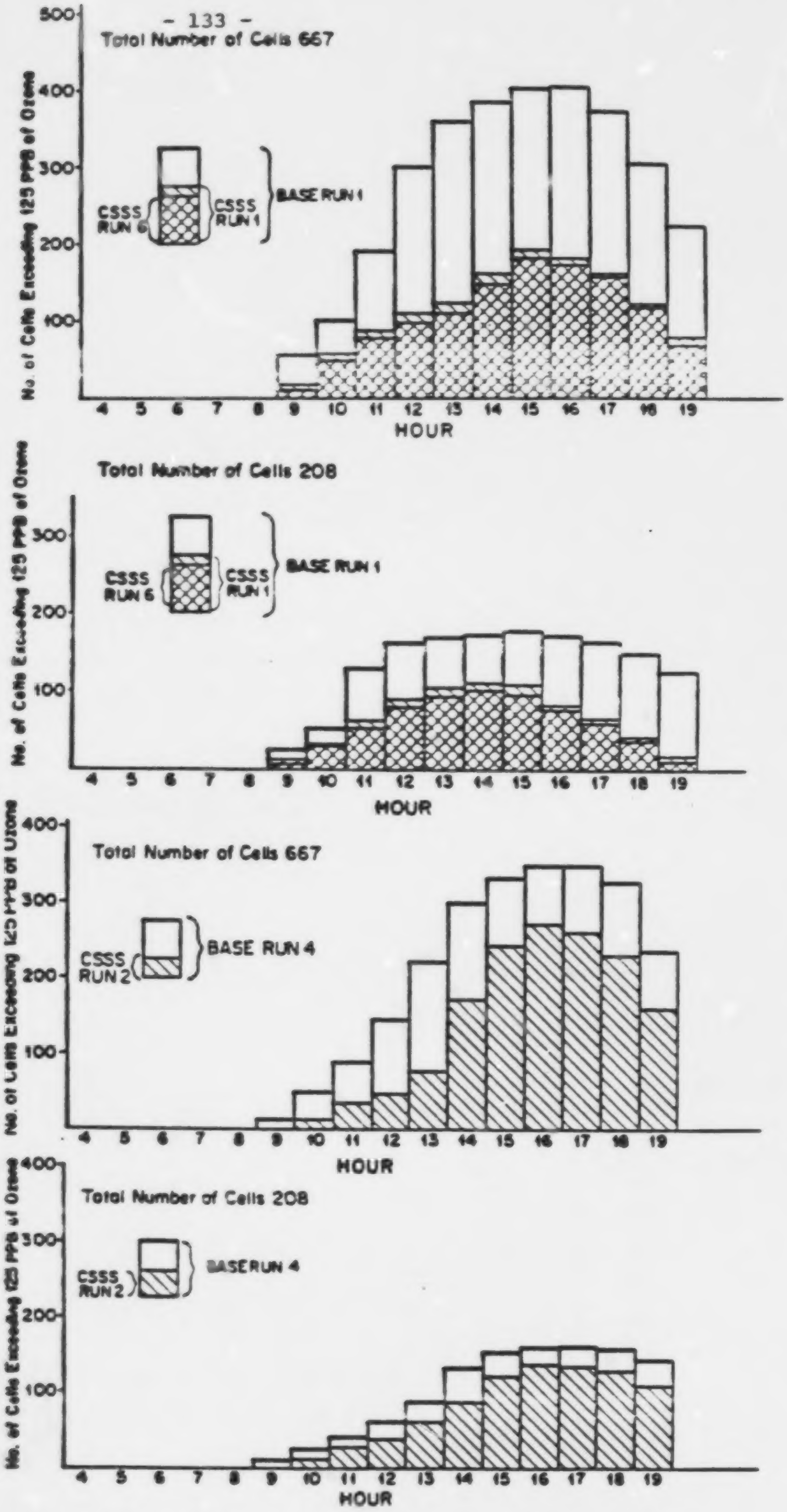


Figure 7.3 Histogram Plot of Cells Exceeding 125 PPb of Ozone for the Base Runs and the Corresponding Projected Year Runs

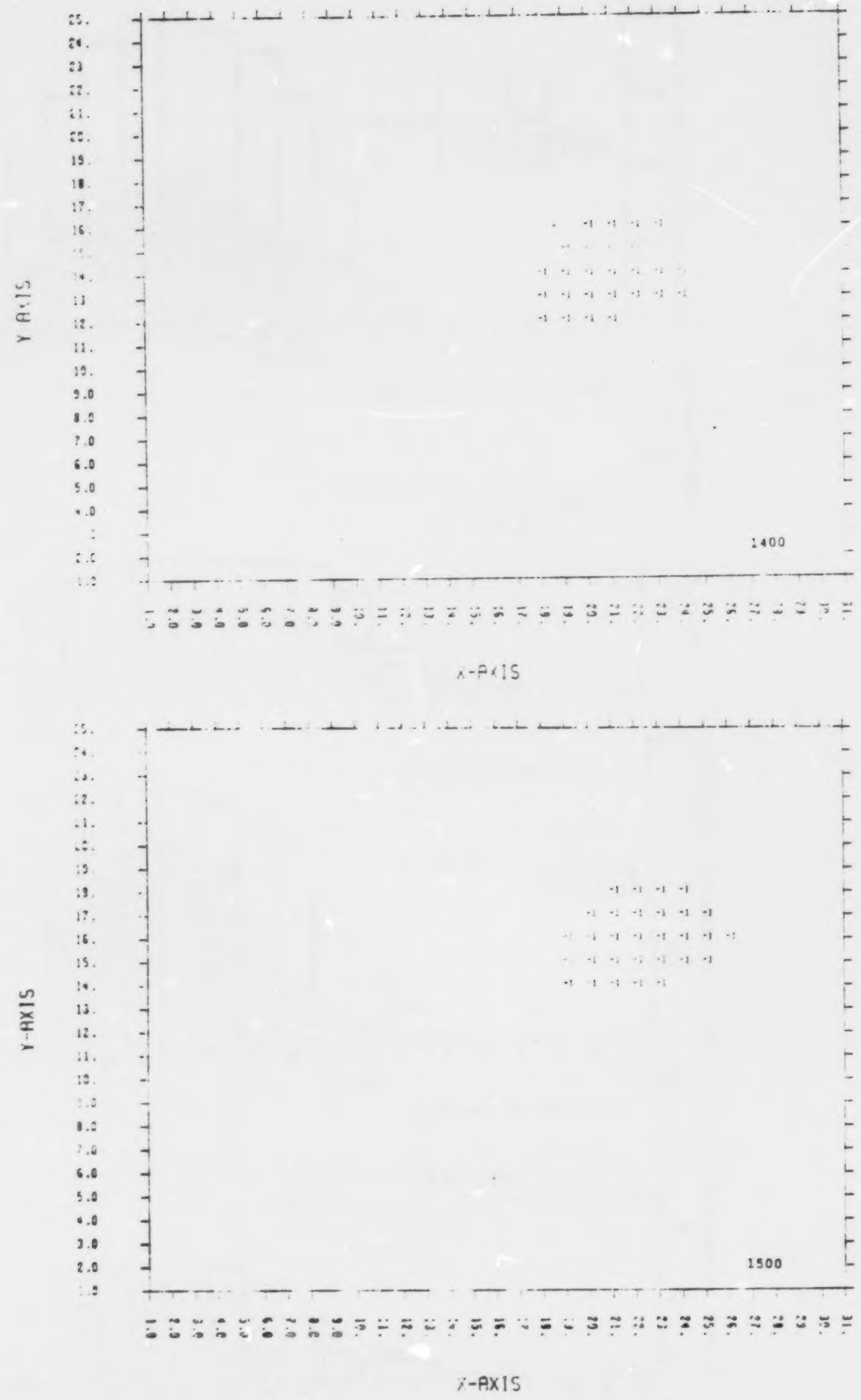

Y-AXIS
X-AXIS
1400
-1
Y-AXIS
X-AXIS
1500
-1

Figure 7.4 Difference Map of Ozone Concentrations (ppb) Between CSSS Run 5 and CSSS Run 1 at 1400 and 1500 Hours

In Figure 7.5 are shown the ozone isopleths for CSSS Run 6. The peak ozone concentration is 175 ppb compared with 185 ppb in the case of CSSS Run 1. The areal extent or the number of cells equal to or exceeding 125 ppb for CSSS Run 6 is shown in Figures 7.3a and 7.3b for the entire domain and for the Connecticut region only. Comparisons between the results of CSSS Run 1 and CSSS Run 6 reveal that the percentage changes in the areal extent is in the range of 8 to 10% for the entire domain, as well as for the Connecticut region alone. Although the controls identified under CSSS Run 6 are not explicitly evaluated with the meteorological conditions prevailing on JD80221(080880), from a comparison of the results of CSSS Run 2 with the corresponding base case it should become evident that these emissions reductions cannot result in ozone concentrations below the level of the ozone NAAQS. Thus, while the reduction in emissions under CSSS Run 6 has resulted in a further reduction in the areal extent of the ozone exceedances, these strategies cannot reduce the peak ozone concentration in the New York Metropolitan area to the level of the ozone NAAQS.

Two other runs, CSSS Run 3 and CSSS Run 4, were performed to evaluate the effects of emissions controls imposed over the Connecticut region only. In CSSS Run 3 the 1980 base year inventory was utilized to exclude all VOC emissions from the Connecticut region, and CSSS Run 4 was based upon a 50% reduction in the 1988 NO_x emissions from Connecticut. The results of these two simulations are presented in terms of the difference maps in Figures 7.6a and 7.6b. In the case of CSSS Run 3, the decrease in the ozone levels is on the order of 6 to 8 ppb over the northeast portion of the domain, while in the case of CSSS Run 4, the change is ±3 ppb. Thus, these reductions of VOC and NO_x emissions in the Connecticut area alone have minimal or no effect on the predicted ozone levels over the modeling domain.

In summary, the UAM simulations for the two days with the control measures identified in the SIPs for the New York Metropolitan area demonstrate that (a) there is an overall improvement in the ozone concentration levels from the 1980 base year, and (b) the peak ozone concentrations would not likely be reduced to levels at or below that of the ozone NAAQS in the 1988 ozone season.

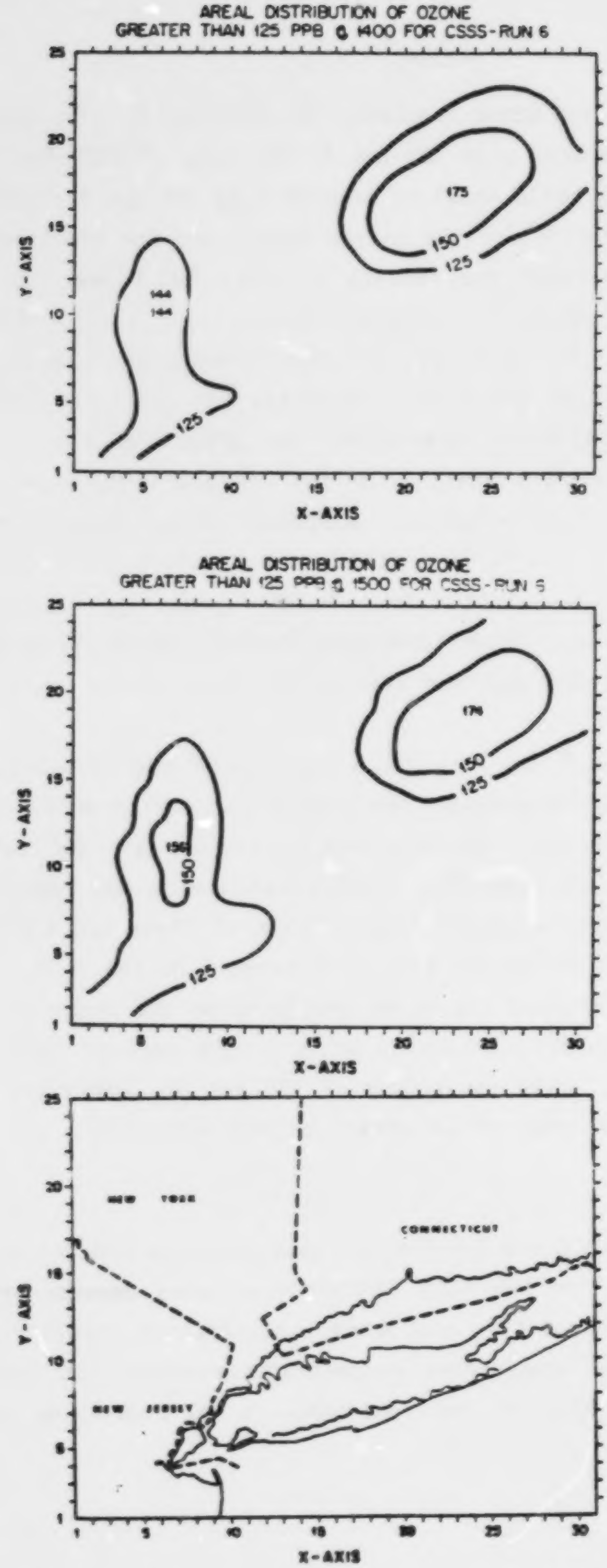
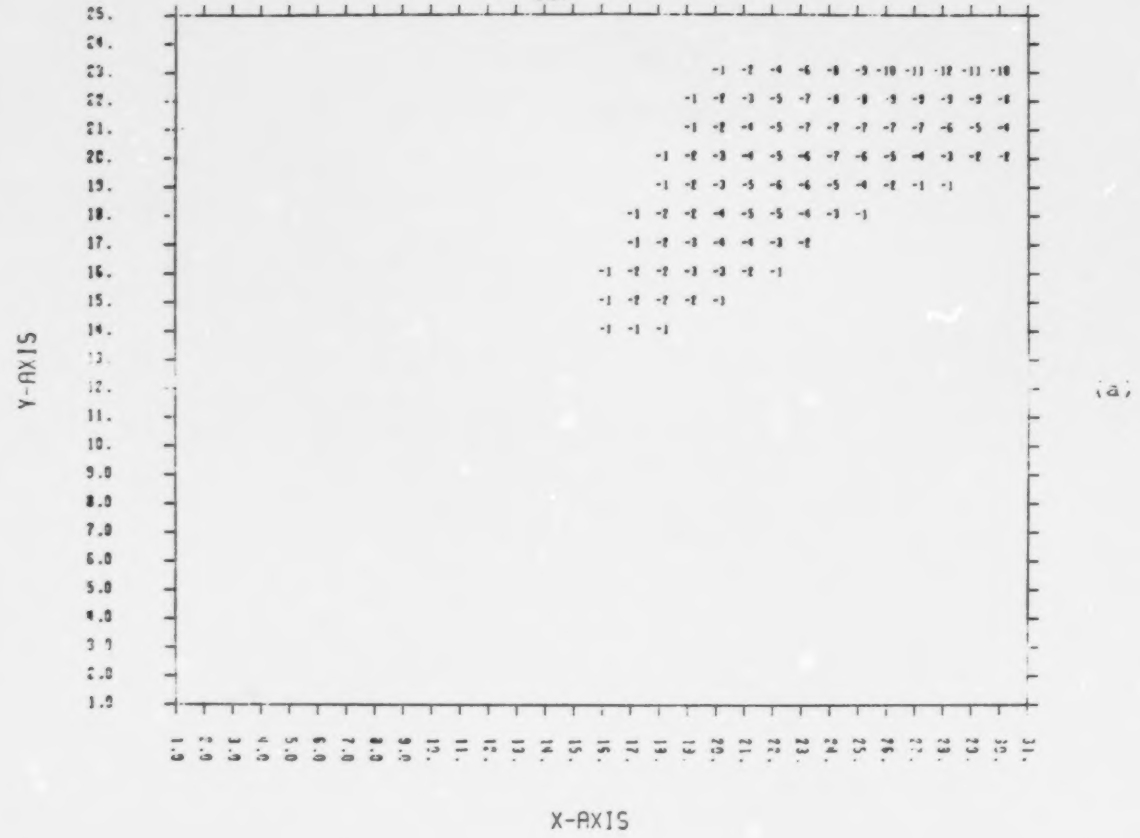


Figure 7.5 Areal Distribution of Ozone at 1400 and 1500 Hours for CSSS Run 6



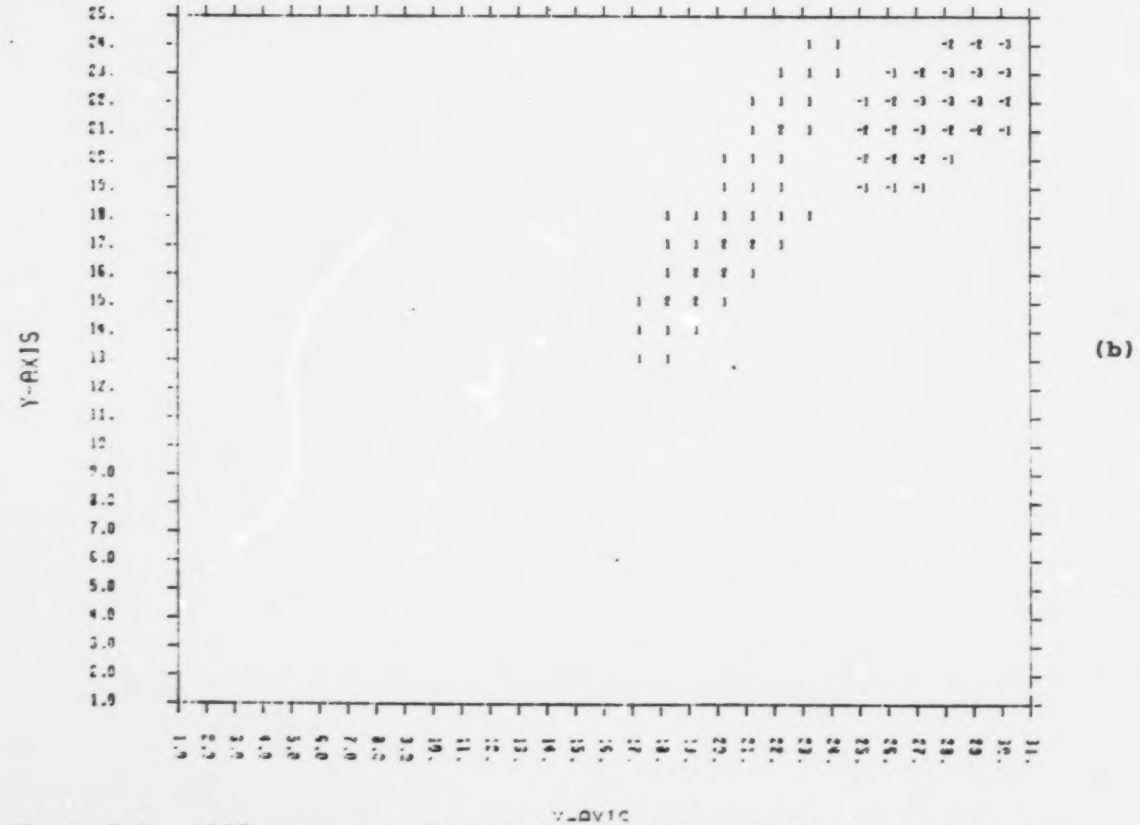


Figure 7.6a Difference Map of Ozone Concentrations (ppb) for CSSS Run 3 and its corresponding Base Case JD80203(072180)

Figure 7.6b Difference Map of Ozone Concentrations (ppb) for CSSS Run 4 and CSSS Run 1

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CHAPTER 8

SENSITIVITY ANALYSIS

Analysis of the control strategy options considered in this study indicates that significant portions of the modeling domain will continue to exceed the NAAQS for ozone during the 1988 ozone season. To understand how some of the input variables affect the predicted ozone concentrations, six sensitivity runs were performed with this data base. For each of these runs, meteorological conditions prevailing on JD80203(072180) were considered, since model evaluation results indicate "best" model performance on this day, with variations in the UAM input data bases of initial and boundary concentrations and emissions. In this section the methodology adopted to perform the sensitivity runs is presented along with the results and their implications.

8.1 Initial and Boundary Concentrations

A set of initial concentrations for the pollutants NMHC, NO_x, O_3, and CO was selected to be representative of "clean" background conditions and is reflective of "minimum" ambient concentration levels. The pollutant concentrations for the "clean" conditions, listed in Table 8.1, are assumed to be uniform across the domain. Similarly, when a "clean" boundary condition was desired, the concentrations in Table 8.1 were used for the boundaries as well as for the region top.

The sensitivity tests were designed to evaluate the influence of initial and boundary concentrations and emissions on the predicted ozone concentrations in the modeling domain. A total of six sensitivity runs, listed in Table 8.2, were performed and the results are discussed below.

8.1.1 Sensitivity Run 1

This simulation was designed to evaluate the effects of initial conditions with "clean" air influx into the modeling domain; the emissions in the domain were "turned off". The initial conditions at the beginning of the simulation reflect the interaction of the base year emissions in the domain up to the start

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TABLE 8.1

"Clean" Pollutant Concentrations Used as Initial/Boundary Conditions in the Sensitivity Analysis

Pollutant	Concentrations (ppb)
O_3	0.1
NO_2	2.0
NO	1.0
NMHC*	5.0
CO	20.0

*ppbc

TABLE 8.2

Summary of Sensitivity Runs

Run	Model Sensitivity To	Model Input: Initial Conditions	Model Input: Boundary Conditions	Model Input: Region Top Concentration	Model Input: Emissions	Model Output
1	Initial Conditions	072180 Base Case*	Clean	Clean	None	Peak O_3 of 107 ppb over CT @ 1000-1100 Hr. No exceedances over NJ and NY.
2	Emissions	Clean	Clean	Clean	1988 Emissions from CSSS Run 1**	Peak O_3 of 43 ppb over CT @ 1700-1800 Hr. No exceedances over NJ and NY.
3	Initial and Lateral Boundary Conditions, and Region Top Concentration	From CSSS Run 1	From CSSS Run 1	From CSSS Run 1	None	Peak O_3 of 158 ppb over CT @ 1400-1500 Hr. and exceedance over NJ and NY.
4	Lateral Boundary Conditions	Clean	From CSSS Run 1	Clean	None	50 ppb over CT; 100 ppb over NY; and exceedances over NJ (southwestern portion of the modeling domain).
5	Lateral Boundary Conditions and Region Top Concentration	Clean	From CSSS Run 1	From CSSS Run 1	None	Wide areas of exceedances over NY, NJ and southwestern CT.
6	Initial Conditions and Emissions	From CSSS Run 1	Clean	Clean	1988 Emissions from CSSS Run 1	Peak impact of 158 ppb over CT @ 1300-1400 Hr. No exceedances over NY and NJ.

*Base case corresponds to 1980 emissions with realistic initial, boundary and region top concentration and predicted peak ozone concentration of 229 ppb over Connecticut (see Figure 6.2).

**The CSSS Run 1 corresponds to 1988 emissions with realistic initial, boundary, and region top concentrations (Table 7.1), and predicted peak ozone concentration of 185 ppb over Connecticut (Figure 7.2).

of the simulation as well as pollutant transport from upwind regions. A peak ozone value of 107 ppb was predicted in the Connecticut region with lower concentrations over the rest of the modeling domain. This run demonstrates that even with the exclusion of emissions and pollutant transport into the modeling domain, reasonable initial conditions alone could produce ozone levels of the order of 100 ppb.

8.1.2 Sensitivity Run 2

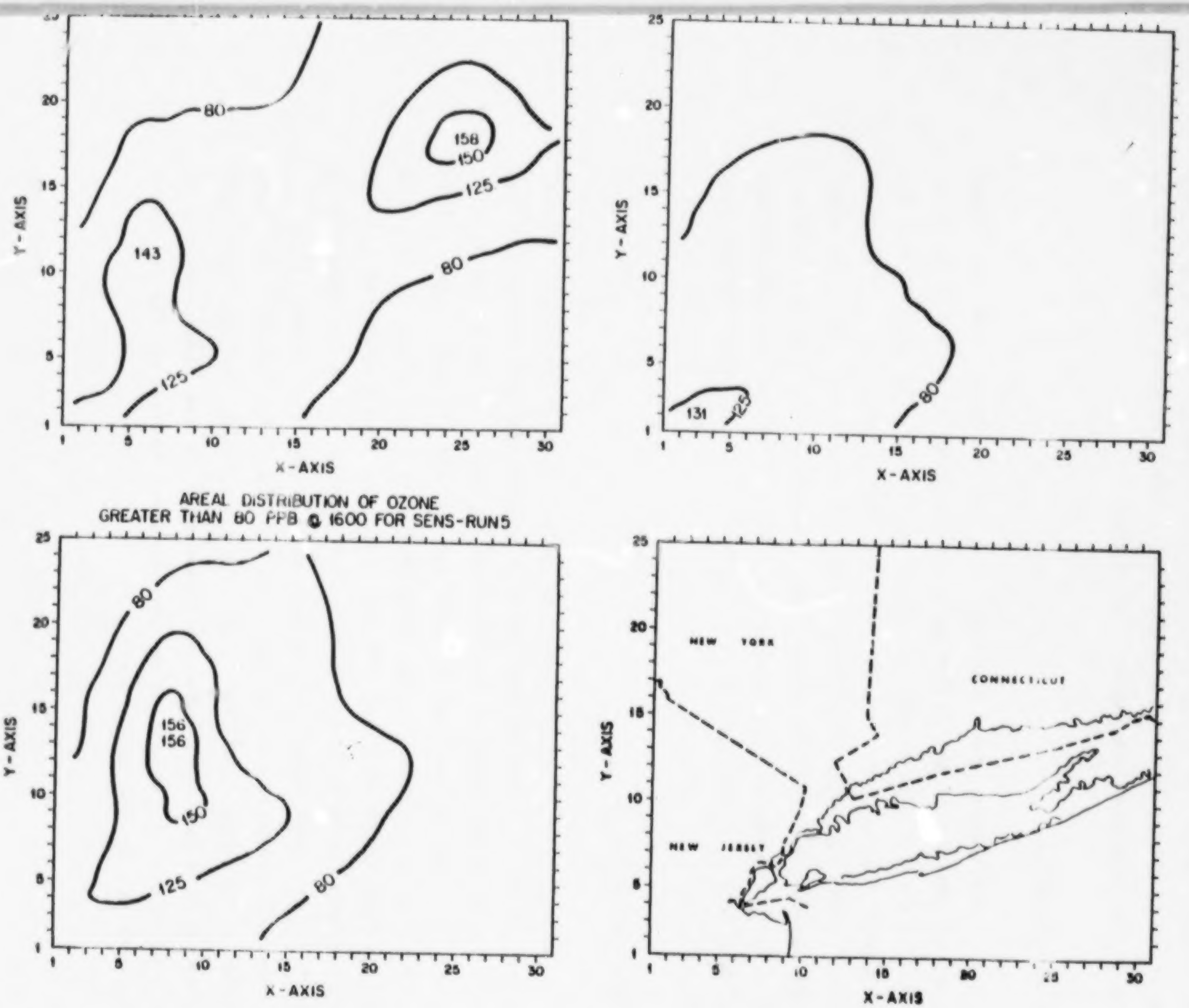
In this simulation, the effect of 1988 emissions alone was evaluated by imposing "clean" pollutant levels both for the initial concentration fields and for the boundary (transport) conditions. The peak value of ozone formed under these conditions was 43 ppb over the Connecticut region, far below the levels projected from CSSS Run 1, indicating the importance of the role of the initial as well as pollutant influx through the lateral boundaries and region top.

8.1.3 Sensitivity Run 3

In contrast to the previous run where "clean" conditions were considered for the initial and transported pollutant fields, this run incorporates "realistic" initial and transported pollutant concentrations from CSSS Run 1 with the emissions "turned off". The effect of these "realistic" conditions is that over the Connecticut region an ozone peak value of 158 ppb was predicted with concentrations exceeding 125 ppb for parts of New York and New Jersey. The areal distribution of ozone for 1400 Hrs., shown in Figure 8.1, has the characteristic double peak formation, revealing the importance of the "realistic" initial and boundary fields.

8.1.4 Sensitivity Run 4

In this run, the influence of the peak ozone levels formed from the lateral transport of pollutants into the domain is examined by setting the concentrations at the top of the region to the "clean" level while retaining the boundary conditions to reflect those of CSSS Run 1. Also, the initial pollutant fields were set to the "clean" conditions with no emissions in the domain. This



AREAL DISTRIBUTION OF OZONE
GREATER THAN 80 PPB @ 1600 FOR SENS-RUN5

Figure 8.1 Ozone Isopleths (PPb) for Sensitivity Runs 3, 4 and 5

simulation, shown in Figure 8.1, indicates ozone concentrations exceeding 125 ppb over New Jersey, and levels reaching 100 and 50 ppb over New York and Connecticut, respectively. This suggests that the boundary fields play a role in the generation of the peak over the New Jersey - New York area in addition to contributing to the peak over the Connecticut region.

8.1.5 Sensitivity Run 5

This run complements the previous run such that the pollutant concentrations at the top of the region were set to those of CSSS Run 1, or to the "realistic" levels. There were no emissions within the domain and the initial pollutant fields were set to the "clean" conditions. The areal distribution of ozone for this simulation, shown in Figure 8.1, has wide areas exceeding 125 ppb over much of New Jersey, New York and portions of southwestern Connecticut. This simulation, in contrast to sensitivity Run 3, demonstrates the role of the initial conditions on the prediction of peak ozone levels over Connecticut.

8.1.6 Sensitivity Run 6

In this run, the effect of inclusion of emissions with realistic initial conditions and "clean" concentrations for the region top and boundaries was examined. This run can be compared with Sensitivity Run 2 in which the initial conditions and transported pollutants were set to the "clean" level. This simulation yields no exceedances of the ozone NAAQS over New Jersey or New York but predicts a peak ozone value of 158 ppb over the Connecticut region. In Figure 8.2 are shown the areal distributions for selected hours for Sensitivity Runs 2 and 6. In both cases no second ozone peak was formed over the New Jersey-New York region indicating the effect of "clean" boundary concentrations. The peak arising from the realistic initial pollutant concentrations in this run shows areas of exceedances of the NAAQS, while with the "clean" conditions it is well below the standard, indicating the influence and importance of the initial pollutant fields.

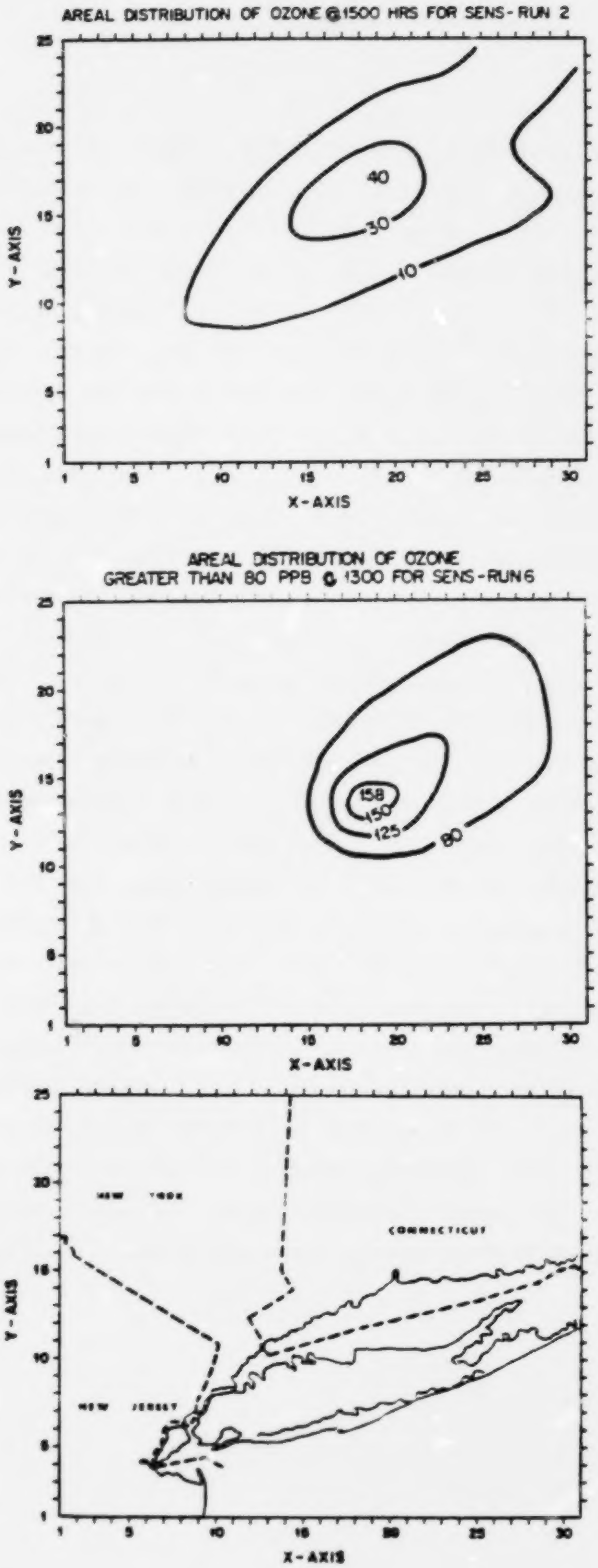


Figure 8.2 Ozone Isopleths (PPb) for Selected Hours for Sensitivity Runs 2 and 6

8.2 Discussion

Six sensitivity runs were performed to examine the effects of transport of pollutants into the New York Metropolitan area coupled with the emissions from the region. In all these runs, the adopted boundary conditions refer either to those included in Table 8.1 as the "clean" influx or to those adopted from CSSS Run 1, as discussed in Chapter 7. It would be prudent to assess whether the ozone concentrations exceeding 125 ppb during 1400 to 1600 Hrs. at the southwest boundary will affect the predicted concentration fields in the New Jersey area. Examination of the isopleths for Sensitivity Run 5 (see Figure 8.1) shows that the peak value of 156 ppb occurs approximately 120 km from the southwest boundary. During this period the winds were from a south-southwesterly direction at 4 to 5 m/s suggesting a travel time of 6 to 8 Hrs. for the airmass from the southwest boundary to reach the location of the peak concentration. Thus, these high ozone levels at this boundary should have little effect on the predicted peak ozone concentration in the New Jersey area. However, the cells near the southwest boundary could be affected by the transport of ozone exceeding 125 ppb (Sensitivity Run 4), and perhaps the peak ozone concentration of 131 ppb in Figure 8.1 could be attributed solely to this high ozone influx. Sensitivity Run 3, in which the emissions have been "turned off" predicts concentrations in excess of NAAQS over the modeling domain just from the initial concentrations and pollutant transport, while Sensitivity Run 6 reveals that "turning off" the influx of concentrations into the domain but including emissions will also result in similar exceedances of the NAAQS over the region. Furthermore, emissions alone within the domain, without the influence of the initial and boundary concentrations (Sensitivity Run 2), result in a peak ozone of 43 ppb over Connecticut. Thus, it is evident that controls or reductions in the emissions levels within the modeling domain should be coupled with reductions in ozone and its precursors transport from the upwind regions in developing meaningful strategies to meet and maintain the NAAQS for ozone in the New York Metropolitan area.

CHAPTER 9

SUMMARY AND CONCLUSIONS

In this study, the Urban Airshed Model (UAM) was used to simulate five high ozone days in the 1980 ozone season. These five days were characterized by exceedances of the ozone NAAQS over wide areas of the New York Metropolitan region consisting of portions of the States of New Jersey, New York, and Connecticut. Typical meteorological conditions associated with high ozone days are as follows: (a) winds from the south to southwest at 4 to 5 m/s, (b) surface temperatures in excess of 80's°F, and (c) a high pressure system over the Atlantic, ridged westward through the southern states.

The New York Metropolitan area lies within the emissions-rich Northeast urban corridor with significant inter-urban transport of ozone and its precursors. All five days simulated show the occurrence of two peaks, one over central Connecticut attributable primarily to emissions from the NY/NJ area, and the other over the northeastern New Jersey and New York border areas attributable to the influx of ozone and its precursors into the modeling domain from the upwind boundary.

The first part of the study was designed to adopt the UAM to the New York Metropolitan area, and to assess the model's performance in simulating observed ozone concentrations. Analysis of modeling results revealed that although the model underpredicts the peak concentrations over the modeling domain, the performance of the model in predicting within the ±30% envelope of the measured concentration levels is reasonable both on an individual day basis as well as on an ensemble basis. The performance statistics of concentrations greater than 100 ppb over the entire modeling domain or over the New Jersey-New York region or over the Connecticut region revealed that at least 60% of the model predictions were within the ±30% of their corresponding observed concentrations.

Of the five days that were simulated, two days, JD80203(072180) and JD80221(080880), were used in the detailed evaluation of the control measures identified in the State Implementation Plans of the three states for attaining the NAAQS for ozone. The reductions in the VOC and NO_x emissions in the modeling region in 1988 were estimated to be 32% and 14%, respectively, from the

1980 base year emissions. Assuming that the SIP and motor vehicle reductions in the upwind emissions will occur in 1988, concentration levels at the boundaries were reduced by 40% in VOC, 20% in NO_x, and 20% in ozone from their 1980 levels. The UAM simulations for the two selected days with the projected 1988 emissions indicate that the peak ozone level over the Connecticut region decreases by about 20% from the 1980 level but is still well above the NAAQS for ozone. The decrease in the areal extent of exceedances of the NAAQS ranges from about 20 to 50% depending upon the simulation day.

Adoption of additional extraordinary emissions controls, as envisioned under the SIPs, upon such source categories as architectural coatings, auto refinishing, consumer/commercial solvents and adoption of small source RACT for the 1988 emissions resulted in a 40% reduction in VOC from the 1980 base year. The UAM simulation using this 1988 emissions inventory revealed that these extraordinary control measures result in only a marginal improvement in the peak ozone level and in the areal extent of the ozone exceedances. Thus, it is evident that even with these proposed control measures of VOC and NO_x emissions in the New York Metropolitan area, the peak ozone levels can be expected to be well above the ozone NAAQS during the 1988 ozone season.

In an attempt to assess the influence of the initial and boundary conditions, and emissions on the predicted ozone levels, several model sensitivity simulations were performed using the JD80203(072180) meteorological conditions. The results indicate that even when the emissions in the New York Metropolitan area are "turned off", transport into the modeling domain alone could lead to exceedances of the NAAQS over the region. Peak ozone levels in this scenario are comparable to those predicted by a 40% VOC emissions reduction strategy (CSSS Run 6). Further, hypothetically "clean" air influx through the boundaries and "realistic" initial conditions and emissions also result in exceedance of the NAAQS. However, neither of these extreme cases, "turning off" the emissions in the modeling domain or having the modeling domain surrounded by "clean" boundaries, are realistic assumptions.

The results presented here strongly suggest that both emissions reductions within the New York Metropolitan area and further reductions in ozone and its precursors transport from the upwind areas are necessary to meet and maintain the ozone NAAQS in the region. Clearly, additional modeling analyses are needed to document the level of control required to achieve the NAAQS for ozone in the New York Metropolitan area.

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APPENDIX A

Temporal and Speciation Factors for Area and Point Source Emissions

The total VOC and NO_x emission inputs were divided into the UAM required hydrocarbon species and/or $NO-NO_2$ splits using the data developed by Engineering Sciences for USEPA (EPA, 1982. Temporal factors for area source emissions detailed in the ES study were adopted in this application.

In the case of point source categories not included in the ES study, appropriate factors were determined based upon similarities in fuels burned and/or process description. For example, emissions from bituminous coal fired utility boilers were assumed to have the same component splits regardless of the manner in which the fuel was burned, and in the following Tables are listed the factors used in the OMNYMAP study:

A.1 HYDROCARBON SPECIATION FACTORS FOR AREA SOURCE EMISSIONS IN THE MODELING DOMAIN

			Paraffins		Olefins		Aromatics		Carbonyls		Ethylene	Diolefins		Alcohols		Acetate		Methane		Other		Aldehydes
SCC		Pol.	Wt%	MW	Wt%	MW	Wt%	MW	Wt%	MW	Wt%	Wt%		Wt%		Wt%		Wt%		Wt%	MW	Wt%
90100111	1	HC	148	646	90	750	50	1250	100	833	0	0		0		0		486		126	278	
90100222	1	HC	148	646	90	750	50	1250	100	833	0	0		0		0		486		126	278	
90100330	1	HC	513	728	0		0		487	300	0	0		0		0		0		0		48
90100440	1	HC	190	636	0		0		700	372	0	0		0		0		110		0		42
90100500	1	HC	300	629	0		20	921	80	300	0	0		0		0		560		40	781	8
90100600	1	HC	454	850	255	311	00	00	00	00	191	05	541	0		0		98		193	283	0
90200111	1	HC	148	646	90	750	50	1250	100	833	0	0		0		0		486		126	278	
90200222	1	HC	148	646	90	750	50	1250	100	833	0	0		0		0		486		126	278	
90200330	1	HC	513	728	0		0		487	300	0	0		0		0		0	0			48
90200440	1	HC	190	636	0		0		700	372	0	0		0		0		110		0		42
90200500	1	HC	300	629	0		20	921	80	300	0	0		0		0		560		40	781	8
90300222	1	HC	148	646	90	750	50	1250	100	633	0	0		0		0		486		126	278	
90300330	1	HC	513	728	0		0		487	300	0	0		0		0		0		0		48
90300440	1	HC	190	636	0		0		700	372	0	0		0		0		110		0		42
90300500	1	HC	300	629	0		20	921	80	300	0	0		0		0		560		40	781	8
90401100	1	HC	96	756	270	685	40	1320	110	726	0	0		80	440	0		282		122	324	
90401200	1	HC	711	145	0		94	780	149	300	0	0		0		0		0		0		
90401300	1	HC	711	145	0		94	780	149	300	0	0		0		0		0		0		
90501100	1	HC	401	1381	0		80	987	250	693	0	0		149	432					17	1658	
90501200	1	HC	502	145	12	280	63	780	155	300	12											
90501300	1	HC	0		99	280	0		0		99	0		0		0		0		0		
90600700	1	HC	277	912	285	384	186	985	38	300	117	0		0		0		77		137	324	3
90600800	1	HC	277	912	285	384	186	985	38	300	117	0		0		0		77		137	324	3
90600900	1	HC	277	912	285	384	186	985	38	300	117	0		0		0		77		137	324	3
90700700	1	HC	427	1569	147	308	199	1115	122	300	107	0		0		0		44		61	332	12
90700800	1	HC	427	1569	147	308	199	1115	122	300	107	0		0		0		44		61	332	12
90702200	1	HC	427	1569	147	308	199	1115	122	300	107	0		0		0		44		61	332	12
90702400	1	HC	530	1965	120	396	120	1780	200	593	0	0		0		0		20		10	260	0
90803100	1	HC	515	1178	150	796	190	972	80	440	40	0		05	790	0		20		40	450	5
90803200	1	HC	515	1178	150	796	190	972	80	440	40	0		05	790	0		20		40	450	5
90803300	1	HC	515	1178	150	796	190	972	80	440	40	0		05	790	0		20		40	450	5
90900440	1	HC	190	636	0		0		700	372	0	0		0		0		110		0		42
90904230	1	HC	427	1569	147	308	199	1115	122	300	107	0		0		0		44		61	332	12
90904430	1	HC	277	912	285	384	186	985	38	300	117	0		0		0		77		137	324	3
91000600	1	HC	948	838	0		0		0		0	0		0		0		42		10	301	0
91000700	1	HC	04	650	0		0		0		0	0		0		0		970		26	320	0
91000800	1	HC	500	1382	0		0		0		0	0		0		0		0		87	1658	0
91000900	1	HC	577	864	0		200	1023	0		0	0		0		0		0		131	1038	0
91002100	1	HC	656	145			0		69	300	0	0		0		0		0		0		0
91002200	1	HC	309	1010	31	308	53	1195	01	741	23	0		183	500	54	1075	230		58	568	0
91002300	1	HC	401	1381	0		80	987	250	693	0	0		169	432					17	1658	
91002400	1	HC	427	1569	147	308	199	1115	122	300	107	0		0		0		44		61	332	12
91002600	1	HC	928	145	17	280	06	780	49	300	0	0		0		0		0		0		0
91005100	1	HC	928	145	17	280	06	780	48	300	0	0		0		0		0		0		0
91005200	1	HC	928	145	17	280	06	780	49	300	0	0		0		0		0		0		0
91308100	1	HC	454	650	255	311	00	00	00	00	191	05	541	0		0		98		193	283	0
91308200	1	HC	492	886	439	431	0		0		194	0		0		0		0		19	260	0
91308300	1	HC	277	912	285	384	186	985	38	300	117	0		0		0		77		137	324	3
91308400	1	HC	96	756	270	655	40	1320	110	726	0	0		90	440	0		282		122	324	
91308500	1	HC	492	886	489	431	0		0		194	0		0		0		0		19	260	0

TABLE A.1 Continued

			Paraffins		Olefins		Aromatics		Carbonyls		Ethylene	Diolefins		Alcohols		Acetate		Methane		Other		Aldehydes
SCC		Pol.	Wt%	MW	Wt%	MW	Wt%	MW	Wt%	MW	Wt%	Wt%		Wt%		Wt%		Wt%		Wt%	MW	Wt%
90100111	1	HC	148	646	90	750	50	1250	100	833	0	0		0		0		486		126	278	
90100222	1	HC	148	646	90	750	50	1250	100	833	0	0		0		0		486		126	278	
90100330	1	HC	513	728	0		0		487	300	0	0		0		0		0		0		48
90100440	1	HC	190	636	0		0		700	372	0	0		0		0		110		0		42
90100500	1	HC	300	629	0		20	921	80	300	0	0		0		0		560		40	781	8
90100600	1	HC	454	850	255	311	00	00	00	00	191	05	541	0		0		98		193	283	0
90200111	1	HC	148	646	90	750	50	1250	100	833	0	0		0		0		486		126	278	
90200222	1	HC	148	646	90	750	50	1250	100	833	0	0		0		0		486		126	278	
90200330	1	HC	513	728	0		0		487	300	0	0		0		0		0	0			48
90200440	1	HC	190	636	0		0		700	372	0	0		0		0		110		0		42
90200500	1	HC	300	629	0		20	921	80	300	0	0		0		0		560		40	781	8
90300222	1	HC	148	646	90	750	50	1250	100	833	0	0		0		0		486		126	278	
90300330	1	HC	513	728	0		0		487	300	0	0		0		0		0		0		48
90300440	1	HC	190	636	0		0		700	372	0	0		0		0		110		0		42
90300500	1	HC	300	629	0		20	921	80	300	0	0		0		0		560		40	781	8
90401100	1	HC	96	756	270	685	40	1320	110	726	0	0		80	440	0		282		122	324	
90401200	1	HC	711	145	0		94	780	149	300	0	0		0		0		0		0		
90401300	1	HC	711	145	0		94	780	149	300	0	0		0		0		0		0		
90501100	1	HC	401	1381	0		80	987	250	693	0	0		169	432					17	1658	
90501200	1	HC	502	145	12	280	63	780	155	300	12											
90501300	1	HC	0		99	280	0		0		99	0		0		0		0		0		
90600700	1	HC	277	912	285	384	186	985	38	300	117	0		0		0		77		137	324	3
90600800	1	HC	277	912	285	384	186	985	38	300	117	0		0		0		77		137	324	3
90600900	1	HC	277	912	285	384	186	985	38	300	117	0		0		0		77		137	324	3
90700700	1	HC	427	1569	147	308	199	1115	122	300	107	0		0		0		44		61	332	12
90700800	1	HC	427	1569	147	308	199	1115	122	300	107	0		0		0		44		61	332	12
90702200	1	HC	427	1569	147	308	199	1115	122	300	107	0		0		0		44		61	332	12
90702400	1	HC	530	1965	120	396	120	1780	200	593	0	0		0		0		20		10	260	0
90803100	1	HC	515	1178	150	796	190	972	80	440	40	0		05	790	0		20		40	450	5
90803200	1	HC	515	1178	150	796	190	972	80	440	40	0		05	790	0		20		40	450	5
90803300	1	HC	515	1178	150	796	190	972	80	440	40	0		05	790	0		20		40	450	5
90900440	1	HC	190	636	0		0		700	372	0	0		0		0		110		0		42
90904230	1	HC	427	1569	147	308	199	1115	122	300	107	0		0		0		44		61	332	12
90904430	1	HC	277	912	285	384	186	985	38	300	117	0		0		0		77		137	324	3
91000600	1	HC	948	838	0		0		0		0	0		0		0		42		10	301	0
91000700	1	HC	04	650	0		0		0		0	0		0		0		970		26	320	0
91000800	1	HC	500	1382	0		0		0		0	0		0		0		0		87	1658	0
91000900	1	HC	577	864	0		200	1023	0		0	0		0		0		0		131	1038	0
91002100	1	HC	656	145			0		69	300	0	0		0		0		0		0		0
91002200	1	HC	309	1010	31	308	53	1195	01	741	23	0		183	500	54	1075	230		58	568	0
91002300	1	HC	401	1381	0		80	987	250	693	0	0		169	432					17	1658	
91002400	1	HC	427	1569	147	308	199	1115	122	300	107	0		0		0		44		61	332	12
91002600	1	HC	928	145	17	280	06	780	48	300	0	0		0		0		0		0		0
91005100	1	HC	928	145	17	280	06	780	48	300	0	0		0		0		0		0		0
91005200	1	HC	928	145	17	280	06	780	48	300	0	0		0		0		0		0		0
91308100	1	HC	454	650	255	311	00	00	00	00	191	05	541	0		0		98		193	283	0
91308200	1	HC	492	886	489	431	0		0		194	0		0		0		0		19	260	0
91308300	1	HC	277	912	285	384	186	985	38	300	117	0		0		0		77		137	324	3
91308400	1	HC	96	756	270	655	40	1320	110	726	0	0		80	440	0		282		122	324	
91308500	1	HC	492	886	489	431	0		0		194	0		0		0		0		19	260	0

TABLE A.2

NOx SPECIATION FACTORS FOR AREA SOURCE EMISSIONS IN THE MODELING DOMAIN

SCC	NO	NO_2
90100111 1	96	4
90100222 1	96	4
90100330 1	75	25
90100440 1	99	1
90100500 1	87	13
90100600 1	85	15
90200111 1	96	4
90200222 1	96	4
90200330 1	99	1
90200440 1	99	1
90200500 1	97	3
90300222 1	96	4
90300330 1	96	4
90300440 1	985	15
90300500 1	945	55
90401100 1	85	15
90600700 1	95	5
90600800 1	95	5
90600900 1	95	5
90700700 1	90	10
90700800 1	90	10
90702200 1	90	10
90702400 1	90	10
90803100 1	97	3
90803200 1	97	3
90803300 1	97	3
90900440 1	98	2
90904230 1	96	4
90904430 1	95	5
91002400 1	90	10
91308100 1	85	15
91308200 1	85	15
91308300 1	95	5
91308400 1	85	15
91308500 1	85	15

HYDROCARBON AND NO_X SPECIATION FACTORS FOR POINT SOURCE EMISSIONS IN THE MODELING DOMAIN

				Paraffins		Olefins		Aromatics		Carbonyls		Ethylene	Diolefins	Alcohols	Acetate	Methane	Other		Aldehydes
	SCC		Pol.	Wt%	MW	Wt%	MW	Wt%	MW	Wt%	MW	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%	MW	Wt%
P	10100201	1	HC	148	644	90	750	50	1250	100	833	0	0	0	0	48			
P	10100201	1	NX	94		6													
P	10100202	1	HC	148	644	90	750	50	1250	100	833	0	0	0	0	48			
P	10100202	1	NX	94		6													
P	10100203	1	HC	148	644	90	750	50	1250	100	833	0	0	0	0	48			
P	10100203	1	NX	94		6													
P	10100299	1	HC	148	644	90	750	50	1250	100	833	0	0	0	0	48			
P	10100299	1	NX	94		6													
P	10100401	1	HC	190	636	0		0		700	372	0	0	0	0	11			
P	10100401	1	NX	98		2													
P	10100402	1	HC	190	636	0		0		700	372	0	0	0	0	11			
P	10100402	1	NX	98		2													
P	10100403	1	HC	190	636	0		0		700	372	0	0	0	0	11			
P	10100403	1	NX	98		2													
P	10100404	1	HC	190	636	0		0		700	372	0	0	0	0	11			
P	10100404	1	NX	98		2													
P	10100501	1	HC	513	728	0		0		487	300	0	0	0	0	0			
P	10100501	1	NX	98		2													
P	10100502	1	HC	513	728	0		0		487	300	0	0	0	0	0			
P	10100502	1	NX	98		2													
P	10100503	1	HC	513	728	0		0		487	300	0	0	0	0	0			
P	10100503	1	NX	98		2													
P	10100601	1	HC	300	629	0		20	921	80	300	0	0	0	0	56			
P	10100601	1	NX	94		6													
P	10100603	1	NX	95		5													
P	10100801	1	HC	0		120	283	0		0		117	0	0	0	82			
P	10100801	1	NX	95		5													
P	10200101	1	HC	148	644	90	750	50	1250	100	833	0	0	0	0	48			
P	10200102	1	NX	94		6													
P	10200104	1	HC	148	644	90	750	50	1250	100	833	0	0	0	0	48			
P	10200104	1	NX	94		6													
P	10200107	1	HC	148	644	90	750	50	1250	100	833	0	0	0	0	48			
P	10200107	1	NX	94		6													
P	10200201	1	HC	148	644	90	750	50	1250	100	833	0	0	0	0	48			
P	10200201	1	NX	98		2													
P	10200202	1	HC	148	644	90	750	50	1250	100	833	0	0	0	0	486	126	278	
P	10200202	1	NX	94		6													
P	10200401	1	HC	190	636	0		0		700	372	0	0	0	0	110	0		
P	10200401	1	NX	98		2													
P	10200402	1	HC	190	636	0		0		700	372	0	0	0	0	110	0		
P	10200402	1	NX	98		2													
P	10200403	1	HC	190	636	0		0		700	372	0	0	0	0	110	0		
P	10200403	1	NX	98		2													
P	10200404	1	NX	98		2													
P	10200501	1	HC	513	728	0		0		487	300	0	0	0	0	0	0		
P	10200501	1	NX	98		2													
P	10200502	1	HC	513	728	0		0		487	300	0	0	0	0	0	0		
P	10200502	1	NX	98		2													
P	10200503	1	HC	513	728	0		0		487	300	0	0	0	0	0	0		
P	10200503	1	NX	98		2													

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P  10200504 1  HC   513   728     0           0         487   300     0     0     0     0     0     0
P  10200504 1  NX    98           2
P  10200601 1  HC   300   629     0          20   921    80   300     0     0     0     0   560    40   781
P  1020C601 1  NX    94           6
P  1020C602 1  HC   300   629     0          20   921    80   300     0     0     0     0   560    40   781
P  1020C602 1  NX    94           6
P  1020C603 1  HC   300   629     0          20   921    80   300     0     0     0     0   560    40   781
P  10200603 1  NX    94           6
P  10200702 1  HC   464   514   175   421     0          76   300     0     0     0     0     7
P  10200702 1  NX    94           6
P  10200704 1  HC   464   514   175   421     0          76   300     0     0     0     0     7
P  10200704 1  NX    94           6
P  10200707 1  HC     0         120   283     0           0         117     0     0     0    82
P  10200707 1  NX    94           6
P  10200708 1  HC     0         120   283     0           0         117     0     0     0    82
P  10200708 1  NX    94           6
P  10200799 1  HC   464   514   175   421     0          76   300     0     0     0     0     7
P  10200799 1  NX    94           6
P  10201201 1  HC   190   636     0           0         700   372     0     0     0     0    11
P  10201201 1  NX    95           5
P  10201302 1  HC   190   636     0           0         700   372     0     0     0     0    11
P  10201302 1  NX    94           6
P  10299997 1  HC   464   514   175   421     0          76   300     0     0     0     0     7
P  10299997 1  NX    94           6
P  10299998 1  HC   464   514   175   421     0          76   300     0     0     0     0     7
P  10299998 1  NX    94           6
P  10299999 1  HC   464   514   175   421     0          76   300     0     0     0     0     7
P  10299999 1  NX    94           6
P  10300102 1  NX    94           6
P  10300106 1  NX    94           6
P  10300107 1  HC   148   646    90   750    50  1250   100   833     0     0     0     0    48
P  10300107 1  NX    94           6
P  10300108 1  NX    94           6
P  10300109 1  HC   148   646    90   750    50  1250   100   833     0     0     0     0   486   126   278
P  10300109 1  NX    94           6
P  1030C110 1  NX    94           6
P  1030C199 1  HC   148   646    90   750    50  1250   100   833     0     0     0     0   486   126   278
P  10300199 1  NX    94           6
P  10300401 1  HC   190   636     0           0         700   372     0     0     0     0   110     0         420
P  10300401 1  NX    98           2
P  10300402 1  HC   190   636     0           0         700   372     0     0     0     0   110     0         420
P  10300402 1  NX    98           2
P  10300403 1  HC   190   636     0           0         700   372     0     0     0     0   110     0         420
P  1030C403 1  NX    98           2
P  1030C501 1  HC   513   728     0           0         487   300     0     0     0     0     0     0         487
P  10300501 1  NX    98           2
P  10300502 1  HC   513   728     0           0         487   300     0     0     0     0     0     0         487
P  10300502 1  NX    98           2
P  10300503 1  HC   513   728     0           0         487   300     0     0     0     0     0     0         487
P  10300503 1  NX    98           2
P  10300602 1  HC   300   629     0          20   921    80   300     0     0     0     0   560    40   781    80
P  1C30C602 1  NX    85          15
P  1030C603 1  HC   360   629     0          20   921    80   300     0     0     0     0   560    40   781    80
P  1030C603 1  NX    85          15
P  10399997 1  HC   464   514   175   421     0          76   300     0     0     0     0    76   209   301     7
P  10399997 1  NX    94           6
P  10500104 1  HC   513   728     0           0         487   300     0     0     0     0     0     0          48
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  10500105 1 NX    98           2
P 1050C106 1 NC   300   629     0          20   921    80   300     0     0           0           0         560    40   781     8
P 1050C106 1 NX    94           6
P 1050C110 1 NC   300   629     0          20   921    80   300     0     0           0           0         560    40   781     8
P 10500110 1 NX    94           6
P 10500205 1 NC   300   629     C          20   921    80   300     0     0           0           0         560    40   781     8
P 10500205 1 NX    94           6
P 10500206 1 NC   300   629     0          20   921    80   300     0     0           0           0         560    40   781     8
P 10500206 1 NX    94           6
P 1050C501 1 NC   513   728     0           0         487   300     0     0           0           0           0     0          48
P 1050C501 1 NX    95           5
P 19999999 1 NC    48   630   439   361   101  1065    32   382   219     0         112   413    08  1001     0   257   610     3
P 19999999 1 NX    94           6
P 20100101 1 NC     0         664   368     0           0         287    70   541     0           0         016   220   350     0
P 20100101 1 NX    97           3
P 20100102 1 NX    97           3
P 20100201 1 NC     0           C           0         30C   300     0     0           0           0         700     0          30
P 2010C201 1 NX    94           6
P 2010C501 1 NC     0         664   368     0           0         287    70   541     0           0          11
P 2010C501 1 NX    98           2
P 2010C901 1 NC     0         664   368     0           0         287    70   541     0           0          11
P 20100901 1 NX    97           3
P 20200101 1 NC     0         664   368     0           0         287    70   541     0           0          11
P 20200101 1 NX    90          1C
P 20200201 1 NC     0           0           0         300   300     0     0           0           0          70
P 20200201 1 NX    94           6
P 20200202 1 NC     0           C           0         300   300     0     0           0           0          70
P 20200202 1 NX    94           6
P 20200301 1 NC   277   912   285   386   186   985    38   300   117     0           0           0           7
P 20200301 1 NX    95           5
P 20200401 1 NC     0         664   368     0           0         287    70   541     0           0          11
P 20200401 1 NX    90          10
P 20400101 1 NC   515  1178   150   796   190   972    80   440    40     0          05   790     0           2
P 20400101 1 NX    97           3
P 20400499 1 NC     0           C           0         300   300     0     0           0           0          70
P 20400499 1 NX    94           6
P 30100601 1 NC   454   850   255   311    00    00    00    00   191    05   541     0           0           9
P 30100699 1 NC   454   850   255   311    00    0C    00    00   191    05   541     0           0           9
P 30100701 1 NC     0           C           0           0           0     0           0           0           0
P 30100799 1 NC    48   63C   439   361   101  1C65    32   382   219     0         112   413    08  1001     0
P 30100901 1 NC     0           2           0           0           0     0           0           0           0  1000   990     0
P 3010C901 1 NX    90          10
P 30100910 1 NC     0           0           0           0           0     0           0           0           0  1000   990     0
P 3010C910 1 NX    90          1C
P 30101002 1 NX    95           5
P 30101099 1 NC     0           0           0           0           0     0           0           0           0  1000   781     0
P 30101199 1 NC     0           0           0           0           0     0           0           0           0  1000   781     0
P 30101301 1 NC    48   630   439   361   101  1C65    32   382   219     0         112   413    08  1001     0   257   610    32
P 30101301 1 NX    95           5
P 30101306 1 NX    95           5
P 30101399 1 NX    95           5
P 30101401 1 NC    48   63C   439   361   101  1C65    32   382   219     0         112   413    08  1C01     0   257   610    32
P 30101402 1 NC    48   630   439   361   101  1C65    32   382   219     0         112   413    08  1001     0   257   610    32
P 30101499 1 NC    48   630   439   361   101  1C65    32   382   219     0         112   413    08  1001     0   257   610    32
P 30101499 1 NX    95           5
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P   30101501 1  HC    0         0         0       970  688    0     0      0
P   30101599 1  HC    0         0         0       970  688    0     0      0        30  621    0      0         0
P   30101800 1  HC    0       448  280    0         0       448     0      0         0         0      0    0    0
P   30101801 1  HC    0       448  280    0         0       448     0      0         0         0      0    0    0
P   30101801 1  HX   95         5
P   30101802 1  HC    0      1000  421    0         0         0     0      0         0         0      0         0
P   30101805 1  HC    0      1000  421    0         0         0     0      0         0         0      0         0
P   30101805 1  HX   95         5
P   30101812 1  HC    0         0         0        09  741    0     0    826  511  165  908    0      0        09
P   30101817 1  HC    0      1000  421    0         0         0     0      0         0         0      0         0
P   30101822 1  HC    0       448  280    0         0       448     0      0         0         0      0    0    0
P   30101822 1  HX   95         5
P   30101827 1  HC    0      1000  421    0         0         0     0      0         0         0      0         0
P   30101832 1  HC    0      1000  421    0         0         0     0      0         0         0      0         0
P   30101837 1  HC    0      1000  421    0         0         0     0      0         0         0      0         0
P   30101891 1  HC    0      1000  421    0         0         0     0      0         0         0      0         0
P   30101899 1  HC    0      1000  421    0         0         0     0      0         0         0      0         0
P   30101903 1  HC   35  538   31  421    0        86  581    0     0      0         0       800     48  263    0
P   30102099 1  HC  305 1078    0        65 1197  105  640    0     0    485  549   40 1162    0      0         0
P   30102399 1  HX   95         5
P   30102404 1  HC  305 1078    0        65 1197  105  640    0     0    485  549   40 1162    0
P   30102499 1  HC  305 1078    0        65 1197  105  640    0     0    485  549   40 1162    0
P   30102620 1  HC  968  930    0        04  921    0         0     0      0         0         0
P   30102620 1  HX   95         5
P   30102699 1  HC 1000  982    0         0         0         0     0      0         0         0
P   30102706 1  HX   95         5
P   30103201 1  HC   48  630  439  361  101 1065   32  382  219     0    112  413   08 1001    0
P   30103399 1  HC  577  864    0       200 1023    0         0     0      0         0         0
P   30103401 1  HC 1000  450    0         0         0         0     0      0         0         0
P   30103499 1  HC 1000  450    0         0         0         0     0      0         0         0
P   30103599 1  HC   48  630  439  361  101 1065   32  382  219     0    112  413   08 1001    0
P   30103599 1  HX   95         5
P   30103999 1  HC   48  630  439  361  101 1065   32  382  219     0    112  413   08 1001    0
P   30104199 1  HC   48  630  439  361  101 1065   32  382  219     0    112  413   08 1001    0
P   30105001 1  HC   48  630  439  361  101 1065   32  382  219     0    112  413   08 1001    0
P   30106001 1  HC   48  630  439  361  101 1065   32  382  219     0    112  413   08 1001    0
P   30106002 1  HC   48  630  439  361  101 1065   32  382  219     0    112  413   08 1001    0
P   30106003 1  HC   48  630  439  361  101 1065   32  382  219     0    112  413   08 1001    0
P   30106004 1  HC   48  630  439  361  101 1065   32  382  219     0    112  413   08 1001    0
P   30106005 1  HC   48  630  439  361  101 1065   32  382  219     0    112  413   08 1001    0    257  610   32
P   30106006 1  HC   48  630  439  361  101 1065   32  382  219     0    112  413   08 1001    0    257  610   32
P   30106007 1  HC   48  630  439  361  101 1065   32  382  219     0    112  413   08 1001    0    257  610   32
P   30106009 1  HC   48  630  439  361  101 1065   32  382  219     0    112  413   08 1001    0    257  610   32
P   30106010 1  HC   48  630  439  361  101 1065   32  382  219     0    112  413   08 1001    0    257  610   32
P   30106099 1  HC   48  630  439  361  101 1065   32  382  219     0    112  413   08 1001    0    257  610   32
P   30106099 1  HX   95         5
P   30109099 1  HC   48  630  439  361  101 1065   32  382  219     0    112  413   08 1001    0    257  610   32
P   30109101 1  HC    0      1000  421    0         0         0     0      0         0         0      0         0
P   30110001 1  HC   48  630  439  361  101 1065   32  382  219     0    112  413   08 1001    0    257  610   32
P   30111001 1  HC  214 1140    0        94  921  142  721    0     0      0       550  891    0      0         0
P   30111102 1  HC 1000  982    0         0         0         0     0      0         0         0      0         0
P   30111103 1  HC 1000  932    0         0         0         0     0      0         0         0      0         0
P   30111199 1  HC 1000  982    0         0         0         0     0      0         0         0      0         0
P   30112002 1  HC   48  630  439  361  101 1065   32  382  219     0    112  413   08 1001    0
P   30112502 1  HC   48  630  439  361  101 1065   32  382  219     0    112  413   08 1001    0
P   30113001 1  HC   48  630  439  361  101 1065   32  382  219     0    112  413   08 1001    0
P   30113299 1  HC    0         0       500 1282    0         0     0      0         0         0
```

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  30125099 1 HC   48  630  439  361  101 1C65   32  382  219    0         112  413   08 1001    0
P 30125801 1 HC    0         C        1000  781    0         0    0           0         0         0
P 30125899 1 HC    0         C           0         0         0    0           0         0         0
P 3012e501 1 HC    0         C        1000  781    0         0    0           0         0         0
P 30130001 1 HC   48  630  439  361  101 1C65   32  382  219    0         112  413   08 1001    0
P 30181001 1 HC   48  630  439  361  101 1065   32  382  219    0         112  413   08 1001    0
P 30190099 1 HC   48  630  439  361  101 1065   32  382  219    0         112  413   08 1001    0
P 30199999 1 HC   48  630  439  361  101 1065   32  382  219    0         112  413   08 1001    0
P 30199999 1 NX   95         5
P 30200202 1 NX   93         7
P 30200301 1 HC  500  441    0           0         0         0    0           0         0        50
P 30200504 1 HC  500  441    0           0         0         0    0           0         0        50
P 3020C504 1 NX   93         7
P 30200754 1 HC  300  629    0          20  921   80  300    0    0           0         0        56
P 3020C754 1 NX   94         6
P 30201203 1 NX   93         7
P 3C201299 1 HC  500  441    C           0         0         0    0           0         0       500    0         0
P 30201299 1 NX   93         7
P 30201501 1 HC  500  441    0           0         0         0    0           0         0       500    0         0
P 30201501 1 NX   93         7
P 30201899 1 HC  500  441    0           0         0         0    0           0         0       500    0         0
P 30203299 1 HC  500  441    0           0         0         0    0           0         0       500    0         0
P 30203299 1 NX   93         7
P 30299998 1 HC  500  441    0           0         0         0    0           0         0       500    0         0
P 30299998 1 NX   93         7
P 30299999 1 HC  500  441    0           0         0         0    0           0         0       500    0         0
P 30299999 1 NX   93         7
P 30300302 1 HC   05  441  3C2  289   07  921    0       277   05  541    0         0       453  233  473    0
P 3030C502 1 NX   95         5
P 3030C303 1 HC   05  441  302  289   07  921    0       277   05  541    0         0       453  233  473    0
P 3030C306 1 HC   05  441  302  289   07  921    0       277   05  541    0         0       453  233  473    0
P 3030C306 1 NX   95         5
P 30300308 1 HC   05  441  3C2  289   07  921    0       277   05  541    0         0       453  233  473    0
P 3030C308 1 NX   95         5
P 30300599 1 HC    0    0    C           0         0         0    0           0         0       158  398  920    0
P 3030C599 1 NX   95         5
P 3C30C807 1 HC    0    0    0           0         0         0    0           0         0       158  398  920    0
P 3030C808 1 NX   95         5
P 3030C813 1 HC    0    0    0           0         0         0    0           0         0       158  398  920    0
P 3030C813 1 NX   95         5
P 3030C899 1 HC    0    0    0           0         0         0    0           0         0       158  398  920    0
P 3030C899 1 NX   95         5
P 3030C901 1 HC   85  972    0          46  921    0         0    0           0         0         0  294  914    0
P 30300901 1 NX   95         5
P 30300902 1 NX   95         5
P 30300904 1 NX   95         5
P 3C3U0911 1 HC  707  583    0           0         0         0    0           0         0       168  125  310    0
P 3030C911 1 NX   95         5
P 3030C920 1 NX   95         5
P 3030C933 1 HC  707  583    0           0         0         0    0           0         0       168  125  310    0
P 30300933 1 NX   95         5
P 3030C934 1 HC  707  583    0           0         0         0    0           0         0       168  125  310    0
P 30300934 1 NX   95         5
P 3030C999 1 HC  707  583    0           0         0         0    0           C         0       168  125  310    0
P 3030C999 1 NX   95         5
P 3040C101 1 HC  381  918              160 1147  120  776         0          80  634   60 1032  101   70         3
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P   30400102 1  HC 381  918            160 1147  120  776         0   80  634  60 1032  101    70         3
P   30400102 1  NX  93         7
P   30400103 1  HC 381  918            160 1147  120  776         0   80  634  60 1032   10
P   30400103 1  NX  93         7
P   30400199 1  HC 381  918            160 1147  120  776         0   80  634  60 1032   10
P   30400199 1  NX  93         7
P   30400201 1  HC 381  918            160 1147  120  776         0   80  634  60 1032   10
P   30400201 1  NX  93         7
P   30400203 1  HC 381  918            160 1147  120  776         0   80  634  60 1032   10
P   30400205 1  HC 381  918            160 1147  120  776         0   80  634  60 1032   10
P   30400205 1  NX  93         7
P   30400299 1  HC 381  918            160 1147  120  776         0   80  634  60 1032   10
P   30400299 1  NX  93         7
P   30400301 1  NX  93         7
P   30400302 1  NX  93         7
P   30400309 1  HC 381  918            160 1147  120  776         0   80  634  60 1032   10
P   30400309 1  NX  93         7
P   30400330 1  NX  93         7
P   30400399 1  HC 381  918            160 1147  120  776         0   80  634  60 1032   10
P   30400399 1  NX  93         7
P   30400401 1  HC 381  918            160 1147  120  776         0   80  634  60 1032   10
P   30400401 1  NX  93         7
P   30400402 1  NX  93         7
P   30400499 1  HC 381  918            160 1147  120  776         0   80  634  60 1032   10
P   30400704 1  NX  93         7
P   30400709 1  NX  93         7
P   30400799 1  NX  93         7
P   30400805 1  NX  93         7
P   30400806 1  NX  93         7
P   30400807 1  NX  93         7
P   30400899 1  HC 381  918            160 1147  120  776         0   80  634  60 1032  101
P   30400899 1  NX  93         7
P   30405001 1  HC 381  918            160 1147  120  776         0   80  634  60 1032  101
P   30405001 1  NX  93         7
P   30499999 1  HC 381  918            160 1147  120  776         0   80  634  60 1032  101
P   30499999 1  NX  93         7
P   30500101 1  HC 970  687   20  281    0         0        20    0    0        0         0
P   30500102 1  HC 970  687   20  281    0         0        20    0    0        0         0
P   30500104 1  HC 970  687   20  281    0         0        20    0    0        0         0
P   30500199 1  HC 576  694  130  551   19  921    0        03    0    0        0       213
P   30500199 1  NX  90        10
P   30500201 1  HC 300  629    0          20  921   80  300    0    0    0        0       560
P   30500201 1  NX  95         5
P   30500305 1  HC 300  629    0          20  921   80  300    0    0    0        0       560
P   30500305 1  NX  92         8
P   30500311 1  NX  92         8
P   30500312 1  NX  92         8
P   30500399 1  HC 300  629    0          20  921   80  300    0    0    0        0       560
P   30500501 1  NX  92         8
P   30500504 1  NX  92         8
P   30500599 1  HC 576  694  130  551   19  921    0        03    0    0        0       213
P   30500599 1  NX  92         8
P   30500801 1  NX  95         5
P   30500899 1  NX  95         5
P   30500901 1  HC 381  918            160 1147  120  776         0   80  634  60 1032  101    70        30
P   30501203 1  NX  98         2
P   30501204 1  HC 576  694  130  551   19  921    0        03    0    0        0       213    62  326    0
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  30501299 1 HC  376  624 130  331    19  921    0        03     0     0         0       275     62  328    0
  30501401 1 HC  300  629   0         20  921   80  300   0     0     0         0       560     40  781   80
P 30501401 1 HX   98        2
P 30501402 1 HC  300  629   0         20  921   80  300   0     0     0         0       560     40  781   80
P 30501402 1 HX   98        2
P 30501410 1 HX   93        2
P 30501414 1 HC  300  629   0         20  921   80  300   0     0     0         0       560     40  781   80
P 30501414 1 HX   98        2
P 30501499 1 HC  300  629   0         20  921   80  300   0     0     0         0       360     40  781   80
P 30501499 1 HX   98        2
P 30501501 1 HX   98        2
P 30501503 1 HC  300  629   0         20  921   80  300   0     0     0         0       560     40  781   80
P 30501503 1 HX   98        2
P 30501599 1 HX   98        2
P 30501603 1 HX   98        2
P 30501604 1 HC  300  629   0         20  921   80  300   0     0     0         0       560     40  781   80
P 30501606 1 HX   98        2
P 30501699 1 HC  300  629   0         20  921   80  300   0     0     0         0        56
P 30501699 1 HX   98        2
P 30504033 1 HC  300  629   0         20  921   80  300   0     0     0         0        56
P 30504033 1 HX   95        5
P 30599999 1 HC  381  918            160 1147  120  776         0    80  634   60 1032   10
P 30599999 1 HX   98        2
P 30600101 1 HC  190  636   0          0       700  372   0     0     0         0        11
P 30600101 1 HX   85       15
P 30600102 1 HC  300  629   0         20  921   80  300   0     0     0         0        56
P 30600102 1 HX   95        5
P 30600103 1 HC  190  636   0          0       700  372   0     0     0         0        11
P 30600103 1 HX   85       15
P 30600104 1 HC  300  629   0         20  921   80  300   0     0     0         0        56
P 30600104 1 HX   85       15
P 30600105 1 HC  300  629   0         20  921   80  500   0     0     0         0        56
P 30600105 1 HX   85       15
P 30600201 1 HC  130  862   0          0       510  300   0     0     0         0        36
P 30600201 1 HX   85       15
P 30600301 1 HC  130  862   0          0       510  300   0     0     0         0        36
P 30600301 1 HX   85       15
P 30600401 1 HC  190  636   0          0       700  372   0     0     0         0        11
P 30600401 1 HX   95        5
P 30600402 1 HC  810  559   0         16  987    0        0     0     0         0         0
P 30600501 1 HC  930  737   0          0         0        0     0     0         0        29
P 30600502 1 HC  810  559   0         16  987    0        0     0     0         0        09
P 30600503 1 HC  930  737   0          0         0        0     0     0         0        29
P 30600504 1 HC  930  737   0          0         0        0     0     0         0        29
P 30600602 1 HC  930  737   0          0         0        0     0     0         0        29
P 30600603 1 HC  930  737   0          0         0        0     0     0         0        29
P 30600701 1 HC 1000  722   0          0         0        0     0     0         0         0
P 30600701 1 HX   95        5
P 30600702 1 HC 1000  722   0          0         0        0     0     0         0         0
P 30600801 1 HC  647  625  01  421    07  962    0        0     0     0         0       286
P 30600802 1 HC  908  441  51  421     0         0        0     0     0         0         0
P 30600803 1 HC  907  857   0         43  959    0        0     0     0         0        33
P 30600804 1 HC  711  580 100  434     0         0        0     0     0         0       133
P 30600805 1 HC  930  737   0          0         0        0     0     0         0        29
P 30600805 1 HX   95        5
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P  30600808  1  MC  647  625   01  421   07  962    0
P  30600807  1  MC  647  625   01  421   07  962    0         0         0         0         0       286
P  30600901  1  NX   95         5
P  30600999  1  MC  300  441    0         0       200  300    0         0         0         0       200
P  30601101  1  MC  810  559    0        16  987    0         0         0         0         0        09
P  30601101  1  NX   95         5
P  30601201  1  MC  810  559    0        16  987    0         0         0         0         0        09
P  30601201  1  NX   95         5
P  30601599  1  NX   95         5
P  30601613  1  MC  810  559    0        16  987    0         0         0         0         0        09
P  30699898  1  MC  810  559    0        16  987    0         0         0         0         0        09
P  30699998  1  MC  810  559    0        16  987    0         0         0         0         0        09
P  30699998  1  NX   95         5
P  30699999  1  MC  937  654    0         0         0         0         0         0         0        26
P  30699999  1  NX   90        10
P  30700401  1  MC  401 1381    0        80  987  250  693    0         0  169  432
P  30700401  1  NX   95         5
P  30700799  1  MC  401 1381    0        80  987  250  693    0         0  169  432
P  30700899  1  MC  401 1381    0        80  987  250  693    0         0  169  432
P  30702099  1  MC    0         0         0       970  688    0         0         0        30  621    0
P  30799999  1  MC  401 1381    0        80  987  250  693    0         0  169  432
P  30799999  1  NX   95         5
P  30800101  1  MC 1000  982    0         0         0         0         0         0         0         0
P  30800102  1  MC 1000  982    0         0         0         0         0         0         0         0
P  30800105  1  MC 1000  982    0         0         0         0         0         0         0         0
P  30800106  1  MC 1000  982    0         0         0         0         0         0         0         0    0    0    0
P  30800107  1  MC 1000  982    0         0         0         0         0         0         0         0    0    0    0
P  30800197  1  MC 1000  982    0         0         0         0         0         0         0         0    0    0    0
P  30800198  1  MC 1000  982    0         0         0         0         0         0         0         0    0    0    0
P  30800199  1  MC 1000  982    0         0         0         0         0         0         0         0    0    0    0
P  30800699  1  MC 1000  982    0         0         0         0         0         0         0         0    0    0    0
P  30800799  1  MC  596  140   86  270  263  770   82  290   36         0    0    0         0         0    0    0    0
P  30800799  1  NX   95         5
P  30900199  1  MC    0    0    0         0         0         0         0         0         0       158  398  920    0
P  30900299  1  MC    0        89  316    0         0        59         0         0         0       733  178  269    0
P  30901099  1  NX   97         3
P  30902099  1  MC    0        89  316    0         0        59         0         0         0       733  178  269    0
P  30902099  1  NX   97         3
P  30999999  1  MC    0        89  316    0         0        59         0         0         0       733  178  269    0
P  30999999  1  NX   97         3
P  32099199  1  MC    0         0         0       500  688    0         0       500  580    0         0    0         0
P  32099999  1  MC    0      1000  421    0         0         0         0         0         0         0
P  33000102  1  MC    0         0         0       500  688    0         0       500  580    0         0
P  33000103  1  MC    0         0         0       500  688    0         0       500  580    0         0
P  33000199  1  MC    0         0         0       500  688    0         0       500  580    0         0
P  33000199  1  NX   95         5
P  33000201  1  MC    0         0         0       500  688    0         0       500  580    0         0
P  33000203  1  MC    0         0         0       500  688    0         0       500  580    0         0
P  33000299  1  MC    0      1000  421    0         0         0         0         0         0         0
P  33000399  1  MC    0         0         0       500  688    0         0       500  580    0         0
P  33000399  1  NX   95         5
P  33000499  1  MC  381  918            160 1147  120  776              0       60  634   60 1032  101
P  39000431  1  NX   95         5
P  39000499  1  MC  381  918            160 1147  120  776              0       60  634   60 1032  101
P  39000499  1  NX   95         5
P  39000508  1  MC  381  918            160 1147  120  776              0       60  634   60 1032  101
P  39000508  1  NX   96         4
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P  3900C531 1  NH    96           4
P  39000599 1  HC   190   636     0           0     0   700   372     0     0           0           0         110
P  3900C599 1  NH    96           4
P  39000699 1  HC   300   629     0          20   921    80   300     0     0           0           0         560
P  3900C699 1  NH    98           2
P  3900C899 1  NH    95           5
P  39001099 1  NH    95           5
P  39099997 1  NH    98           2
P  39999999 1  HC   596   140    86   270   263   770    82   290    36     0     0     0           0           0
P  39999999 1  NH    95           5
P  40100101 1  HC     0           0           0           0           0     0           0           0           0
P  40100102 1  HC  1000  1382     0           0           0           0     0           0           0           0
P  40100105 1  HC  1000  1382     0           0           0           0     0           0           0           0
P  4010C201 1  HC  1000  1382     0           0           0           0     0           0           0           0
P  4010C202 1  HC     0           0           0           0           0     0           0           0           0
P  4010C203 1  HC     0           0           0           0           0     0           0           0           0
P  4010C204 1  HC     0           0           0           0           0     0           0           0           0
P  40100205 1  HC     0         213   280     0           0         213     0           0           0           0
P  4010C299 1  HC     0           0           0           0           0     0           0           0           0
P  40199999 1  HC     0           0        1000   921     0           0     0           0           0           0
P  4020C101 1  HC     0           0         774   958   226   638     0     0           0           0           0
P  4020C101 1  NH    90          10
P  40200102 1  HC     0           0           0        1000   581     0     0           0           0           0
P  40200110 1  HC     0           0         774   958   226   638     0     0           0           0           0
P  40200199 1  HC     0           0         760   958   240   638     0     0           0           0           0
P  4020C199 1  NH    90          10
P  4020C299 1  HC     0           0           0         970   688     0     0           0          30   621     0     0     0     0
P  40200301 1  HC     0           0           0         970   688     0     0           0          30   621     0     0     0     0
P  4020C399 1  HC     0           0           0         970   688     0     0           0          30   621     0     0     0     0
P  4020C401 1  HC   250  1140     0         170   974   390   703     0     0         150   601    40  1400     0     0           0
P  4020C406 1  HC   268  1101    57   531    21   921    39   324     0     0          70   601   452  1084    90    03   260    33
P  4020C499 1  HC   174  1009     0         139   921   166   721     0     0         157   631   364  1137     0     0           0
P  4020C501 1  HC   676  1140     0          72   994   158   688     0     0          59   578    35  1123     0     0           0
P  4020C501 1  NH    90          10
P  40200503 1  HC     0           0           0        1000   721     0     0           0           0           0     0           0
P  4020C510 1  HC   676  1140     0          72   994   158   688     0     0          59   578    35  1123     0     0           0
P  4020C599 1  HC   676  1140     0          72   994   158   688     0     0          59   578    35  1123     0     0           0
P  4020C599 1  NH    90          10
P  40200601 1  HC     0           0          87   921   689   581     0     0           0           0           0   224   781     0
P  4020C699 1  HC   917  1140     0          83  1012     0           0     0           0           0           0     0           0
P  4020C701 1  HC     0           0         760   958   240   638     0     0           0           0           0     0           0
P  4020C701 1  NH    90          10
P  4020C706 1  HC     0           0         760   958   240   638     0     0           0           0           0
P  4020C799 1  HC     0           0         760   958   240   638     0     0           0           0           0
P  4020C801 1  HC   265   560    20   280     0           0          20     0           0           0          66
P  4020C801 1  NH    90          10
P  4020C802 1  HC     0           0           0         970   688     0     0           0          30   621     0
P  4020C802 1  NH    90          10
P  4020C803 1  HC     0          24   280   106   921   302   581    24     0           0           0          39
P  4020C803 1  NH    90          10
P  40200898 1  HC   268  1101    57   531    21   921    39   324     0     0          70   601   452  1084     9
P  4020C898 1  NH    90          10
P  40200899 1  HC   268  1101    57   531    21   921    39   324     0     0          70   601   452  1084     9
P  4020C901 1  HC   401  1381     0          80   987   250   693     0     0         169   432     0           0
P  40200902 1  HC     0           0           0        1000   581     0     0           0           0           0
P  40200904 1  HC     0           0           0           0           0     0        1000   741     0           0
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P   40200910 1  HC 100C  460    0          0          0         0    0     0         0        0
P   40200917 1  HC    0         C          0          0         0    0  1000  320    0        0
P   4020C918 1  HC    0         0          0       1000  721    0    0     0         0        0
P   4020C920 1  HC 10C0 1140    C          0          0         0    0     0         0        0
P   4020C921 1  HC    0         0        760  958   240  638    0    0     0         0        0
P   4020C922 1  HC    0         0          0        970  688    0    0     0        30  621    0
P   40201101 1  HC   70  512  170  3C8     0          0       130    0     0         0       69
P   40201103 1  HC   70  512  170  3C8     0          0       130    0     0         0       69
P   40201301 1  HC   70  512  170  308     0          0       130    0     0         0       69
P   40201399 1  HC   70  512  170  308     0          0       130    0     0         0       69
P   40201721 1  HC  401 1381    C         80  987   250  693    0    0   169  432
P   40201722 1  HC  401 1381    0         80  987   250  693    C    0   169  432
P   40201726 1  HC  401 1381    C         80  987   250  693    0    0   169  432
P   40201727 1  HC  401 1381    0         80  987   250  693    0    0   169  432
P   40201799 1  HC  401 1381    0         80  987   250  693    0    0   169  432
P   40201801 1  HC  401 1381    0         80  987   250  693    0    0   169  432
P   40201801 1  HN   90        10
P   40201806 1  HC  401 1381    0         80  987   250  693    0    0   169  432
P   40202103 1  HC    0         C          0        970  688    0    0     0        30  621    0
P   40202301 1  HC  401 1381    0         80  987   250  693    0    0   169  432
P   40202306 1  HC  401 1381    0         80  987   250  693    0    0   169  432
P   40202401 1  HC  401 1381    0         80  987   250  693    0    0   169  432
P   40202406 1  HC  401 1381    0         80  987   250  693    0    0   169  432
P   40202501 1  HC  401 1381    0         80  987   250  693    0    0   169  432                  17  1658
P   40299999 1  HC  214 1140    0         94  921   142  721    0    0     0       550  891    0     0         0
P   40299999 1  HN   90        10
P   4030C101 1  HC  928  145   17  280    06  780    48  300    0    0     0         0        0     0         0
P   40300102 1  HC  881  640    0          0          0          0    0     0         0       62    57   303   0
P   40300103 1  HC  928  145   17  280    06  780    48  300    0    0     0         0        0     0         0
P   40300104 1  HC  847  621    0         14  921     0          0    0     0         0       88    51   424   0
P   4030C105 1  HC  847  621    0         14  921     0          0    0     0         0       88    51   424   0
P   4030C106 1  HC  847  621    0         14  921     0          0    0     0         0       88    51   424   0
P   4030C107 1  HC  847  621    0         14  921     0          0    0     0         0       88    51   424   0
P   4030C108 1  HC    0         0          0          0          0    0     0         0        0  1000   781   0
P   4030C116 1  HC    0         0       1000  921     0          0    0     0         0        0     0         0
P   40300150 1  HC 1000 1652    0          0          0          0    0     0         0        0     0         0
P   4030C151 1  HC  881  640    0          0          0          0    0     0         0       62    57   303   0
P   4C3UC152 1  HC 1000 1652    0          0          0          0    0     0         0        0     0         0
P   4030C153 1  HC    0         0          0          0          0    0     0         0        0  1000   781   0
P   40300160 1  HC    0         0       1000  921     0          0    0     0         0        0     0         0
P   4030C161 1  HC    0         C       1000  921     0          0    0     0         0        0     0         0
P   40300198 1  HC 1000  790    C          0          0          0    0     0         0        0     0         0
P   40300199 1  HC 1000 1652    0          0          0          0    0     0         0        0     0         0
P   4030C201 1  HC  928  145   17  280    06  780    48  300    0    0     0         0        0     0         0
P   4030G202 1  HC  928  145   17  28C    06  780    48  300    0    0     0         0        0     0         0
P   4030C203 1  HC  847  621    0         14  921     0          0    0     0         0       88    51   424   0
P   40300204 1  HC  847  621    0         14  921     0          0    0     0         0       88    51   424   0
P   4030C205 1  HC 1000 1652    0          0          0          0    0     0         0        0     0         0
P   40300206 1  HC  847  621    0         14  921     0          0    0     0         0       88    51   424   0
P   4030C207 1  HC  847  621    0         14  921     0          0    0     0         0       88    51   424   0
P   4030C208 1  HC    0         0          0          0          0    0     0         0        0  1000   781   0
P   4030C211 1  HC 10C0 1C02    0          0          0          0    0     0         0        0     0     0   0
P   40300212 1  HC 1000  862    0          0          0          0    0     0         0        0     0         0
P   40300216 1  HC    0         0       1000  921     0          0    0     0         0        0     0         0
P   40300299 1  HC 1000 1652    0          0          0          0    0     0         0        0     0         0
P   403GC3C2 1  HC  928  145   17  280    06  780    48  300    0    0     0         0        0     0         0
P   40300306 1  HC  847  621    C         14  921     0          0    0     0         0       88    51   424   0
```

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                                        0         0         0    0    0         0         0    0         0
  40300398 1 NC  908  441   51  421    0         0         0    0    0         0         0   41  301    0
  40300399 1 NC  908  441   51  421    0         0         0    0    0         0         0   41  301    0
P 40301010 1 NC  881  640    0          0         0         0    0    0         0        62   57  303    0
P 40301019 1 NC  948  838    0          0         0         0    0    0         0        42   10  301    0
P 40301020 1 NC  948  838    0          0         0         0    0    0         0        42   10  301    0
P 40301099 1 NC 1000  862    0          0         0         0    0    0         0         0    0         0
P 40301102 1 NC  928  145   17  280   06  780   48  300    0    0    0         0         0    0         0
P 40301109 1 NC  881  640    0          0         0         0    0    0         0        62   57  303    0
P 40301198 1 NC  928  145   17  280   06  780   48  300    0    0    0         0         0    0         0
P 40301199 1 NC  948  838    0          0         0         0    0    0         0        42   10  301    0
P 40301299 1 NC  948  838    0          0         0         0    0    0         0        42   10  301    0
P 40302001 1 NC 1000  862    0          0         0         0    0    0         0         0    0         0
P 40399999 1 NC 1000 1652    0          0         0         0    0    0         0         0    0         0
P 40400101 1 NC  928  145   17  280   06  780   48  300    0    0    0         0         0    0         0
P 40400110 1 NC  928  145   17  280   06  780   48  300    0    0    0         0         0    0         0
P 40400111 1 NC  928  145   17  280   06  780   48  300    0    0    0         0         0    0         0
P 40400112 1 NC  928  145   17  280   06  780   48  300    0    0    0         0         0    0         0
P 40400199 1 NC  928  145   17  280   06  780   48  300    0    0    0         0         0    0         0
P 40500101 1 NC   70  512  170  308    0          0       130    0    0         0       690   70  301    0
P 40500201 1 NC   70  512  170  308    0          0       130    0    0         0       690   70  301    0
P 40500301 1 NC    0          0          0        09  741    0    0  826  511  165  908    0    0        09
P 40500304 1 NC    0          0          0         0         0    0 1000  461    0         0    0         0
P 40500305 1 NC    0          0          0        09  741    0    0  826  511  165  908    0    0         0
P 40500306 1 NC    0          0          0        09  741    0    0  826  511  165  908    0    0         0
P 40500311 1 NC    0          0          0        09  741    0    0  826  511  165  908    0    0         0
P 40500399 1 NC    0          0          0        09  741    0    0  826  511  165  908    0    0         0
P 40500401 1 NC  166  547    0          0         0         0    0   09  601    0       377  160  604    0
P 40500499 1 NC  166  547    0          0         0         0    0   09  601    0       377  160  604    0
P 40500501 1 NC  192  990    0        120  921   86  705    0    0  197  530  405  966    0    0         0
P 40500506 1 NC  610 1077    0        130 1195    0         0    0  180  489   80 1162    0    0         0
P 40500511 1 NC    0          0          0        09  741    0    0  826  511  165  908    0    0         0
P 40500598 1 NC  830 1140    0        170  951    0         0    0    0         0         0    0         0
P 40500599 1 NC  830 1140    0        170  951    0         0    0    0         0         0    0         0
P 40560101 1 NC  830 1140    0        170  951    0         0    0    0         0         0    0         0
P 40600101 1 NC  928  145   17  280   06  780   48  300    0    0    0         0         0    0         0
P 40600105 1 NC 1000 1652    0          0         0         0    0    0         0         0    0         0
P 40600126 1 NC  928  145   17  280   06  760   48  300    0    0    0         0         0    0         0
P 40600126 1 MX   90        10
P 40600127 1 NC  847  621    0         14  921    0         0    0    0         0        88   51  424    0
P 40600130 1 NC 1000 1652    0          0         0         0    0    0         0         0    0         0
P 40600131 1 NC  928  145   17  280   06  780   48  300    0    0    0         0         0    0         0
P 40600135 1 NC  948  838    0          0         0         0    0    0         0        42   10  301    0
P 40600140 1 NC 1000 1652    0          0         0         0    0    0         0         0    0         0
P 40600197 1 NC  928  145   17  280   06  780   48  300    0    0    0         0         0    0         0
P 40600198 1 NC  928  145   17  280   06  780   48  300    0    0    0         0         0    0         0
P 40600199 1 NC  928  145   17  280   06  780   48  300    0    0    0         0         0    0         0
P 40600240 1 NC  928  145   17  280   06  780   48  300    0    0    0         0         0    0         0
P 40600253 1 NC  881  640    0          0         0         0    0    0         0        62   57  303    0
P 40600304 1 NC  928  145   17  280   06  780   48  300    0    0    0         0         0    0         0
P 40600401 1 NC  928  145   17  280   06  780   48  300    0    0    0         0         0    0         0
P 49000105 1 NC    0        448  280    0          0       448    0    0         0         0
P 49000199 1 NC    0          0       760  958  240  638    0    0    0         0         0
P 49000299 1 NC    0          0       760  958  240  638    0    0    0         0         0
P 49099999 1 NC  610 1077    0        130 1195    0         0    0  180  489   80 1162    0
P 50100101 1 NC   96  756  270  685   40 1320  110  726    0    0   80  440    0       282
P 50100101 1 MX   85        15
```

```
P   50100102 1  NC   96  756  270  685   40 1320  110  726    0      0          80  440    0      282
P   50100102 1  NX   85       15
P   50100505 1  NX   85       15
P   5010C506 1  NC    0        92  284    0        0         87      0           0         0      804
P   5010C506 1  NX   85       15
P   5020C101 1  NC   96  756  270  685   40 1320  110  726    0      0          80  440    0      282
P   50200101 1  NX   85       15
P   50200102 1  NC   96  756  270  685   40 1320  110  726    0      0          80  440    0      282
P   5020C102 1  NX   85       15
P   5020C505 1  NC   96  756  270  685   40 1320  110  726    0      0          80  440    0      282
P   5020C505 1  NX   85       15
P   5030C101 1  NC   96  756  270  685   40 1320  110  726    0      0          80  440    0      282
P   5030C101 1  NX   85       15
P   5030C102 1  NC   96  756  270  685   40 1320  110  726    0      0          80  440    0      282
P   50300102 1  NX   85       15
P   5030C103 1  NC   96  756  270  685   40 1320  110  726    0      0          80  440    0      282
P   5030C103 1  NX   85       15
P   50300106 1  NX   85       15
P   50300202 1  NC   96  756  270  685   40 1320  110  726    0      0          80  440    0       28
P   50300202 1  NX   85       15
P   5030C506 1  NC   96  756  270  685   40 1320  110  726    0      0          80  440    0       28
P   5030C599 1  NC   96  756  270  685   40 1320  110  726    0      0          80  440    0       28
P   5030C599 1  NX   85       15
P   5039C006 1  NX   95        5
P   5039C010 1  NX   95        5
P   59999999 1  NC   96  756  270  685   40 1320  110  726    0      0          80  440    0       28
P   60199999 1  NC  596  140   86  270  263  770   82  290   36      0     0     0         0        0
EOF 1647
0:
```

TABLE A.4
NEW YORK MINOR POINT SOURCE SPECIATION FACTORS

CHEMICAL NAME	CAS NO.	% AROMATIC	% CARBONYL	% ETHYLENE	% OLEFIN	% PARAFFIN	TONS	% OF TOTAL	CUMUL %
TOTAL ORGANIC SOLVENTS	NY998-00-0	18	22	0	0	40	5188	17.1	17.1
MISC. ORGANICS	NY990-00-0	22	7	3	2	50	2311	7.6	24.8
METHYL ETHYL KETONE	00078-93-3	0	40	0	0	58	2277	7.5	32.3
TOLULENE	00108-88-3	84	0	0	0	15	2031	6.7	39.0
ORGANIC SOLVENTS	NY930-00-0	22	7	3	2	50	1866	6.2	45.1
ETHANOL	00064-17-5	0	0	0	0	61	1782	5.9	51.0
DIMETHYLFORMANIDE	00068-12-2	0	0	0	0	0	1575	5.2	56.2
OTHER ALIPHATIC EST	NY690-00-0	0	28	0	0	55	1373	4.5	60.8
ALIPHATIC ALCOHOLS	NY580-00-0	0	0	0	0	63	1248	4.1	64.9
OTHER ALIPHATIC KETONES	NY645-00-0	0	40	0	0	59	1040	3.4	68.3
ALIPHATIC HYDROCARBONS	NY550-00-0	0	13	2	3	89	960	3.2	71.5
ISOPROPYL ALCOHOL	00067-63-0	0	0	0	0	70	744	2.5	73.9
TETRACHLOROETHYLENE	00127-18-4	0	0	0	0	0	687	2.3	76.2
TRICHLOROETHYLENE	00079-01-6	0	0	28	0	0	625	2.1	78.3
ACETONE	00067-64-1	0	50	0	0	48	604	2.0	80.3
HYDROCARBONS-MISC.	68476-39-1	22	7	3	2	50	569	1.9	82.1
XYLENE,M O&P MIX	01330-20-7	73	0	0	0	26	514	1.7	83.8
NAPTHENES (CYCLO)	NY335-00-0	0	29	0	0	86	467	1.5	85.4
METHANOL	00067-56-1	0	0	0	0	44	417	1.4	86.7
TOTAL HYDROCARBONS	NY495-00-0	19	5	4	3	56	379	1.3	88.0
THER ALIPHATIC CHLORINE	NY740-00-0	0	0	15	0	0	367	1.2	89.2
OTHER ACETATES	NY685-00-0	0	28	0	0	55	353	1.2	90.4
PAINT THINNER	NY920-00-0	0	19	0	0	38	349	1.2	91.5
OTHER ALIPHATIC ET	NY595-00-0	0	39	0	0	57	323	1.1	92.6
AROMATIC NITROGEN	NY435-00-0	83	0	0	0	0	302	1.0	93.6
METHYL ISOBUTYL KETONE	00108-10-1	0	29	0	0	70	214	0.7	94.3
THER ALIPHATIC HALOGENS	NY780-00-0	0	0	15	0	0	196	0.6	94.9
ISOBUTYL ALCOHOL	00078-83-1	0	0	0	0	76	188	0.6	95.6
NAPTHALENE	00091-20-3	60	0	0	0	44	184	0.6	96.2
ISOPROPYL ACETATE	00108-21-4	0	28	0	0	55	161	0.5	96.7
OTHER ALIPHATIC AMIN	NY830-00-0	0	0	0	0	62	140	0.5	97.2
NONMETHANE ALKANES	NY520-00-0	0	0	0	0	98	77	0.3	97.4
OT ALIPHATIC HYDROCARBON	NY559-00-0	0	13	2	3	89	72	0.2	97.7
PYRIDENE	00110-86-1	0	0	0	0	18	60	0.2	97.9
NONSPECIFIC ODOROUS	NY950-00-0	22	7	3	2	50	60	0.2	98.1

APPENDIX B

Diurnal Plots of Predicted and Measured Ozone Concentrations

The diurnal variation of the measured and predicted ozone concentrations at the monitoring stations in the OMNYMAP domain, see Figure B-1, are presented for each of the five days. These diurnal plots presented in this manner are helpful in providing a qualitative assessment of the UAM performance.

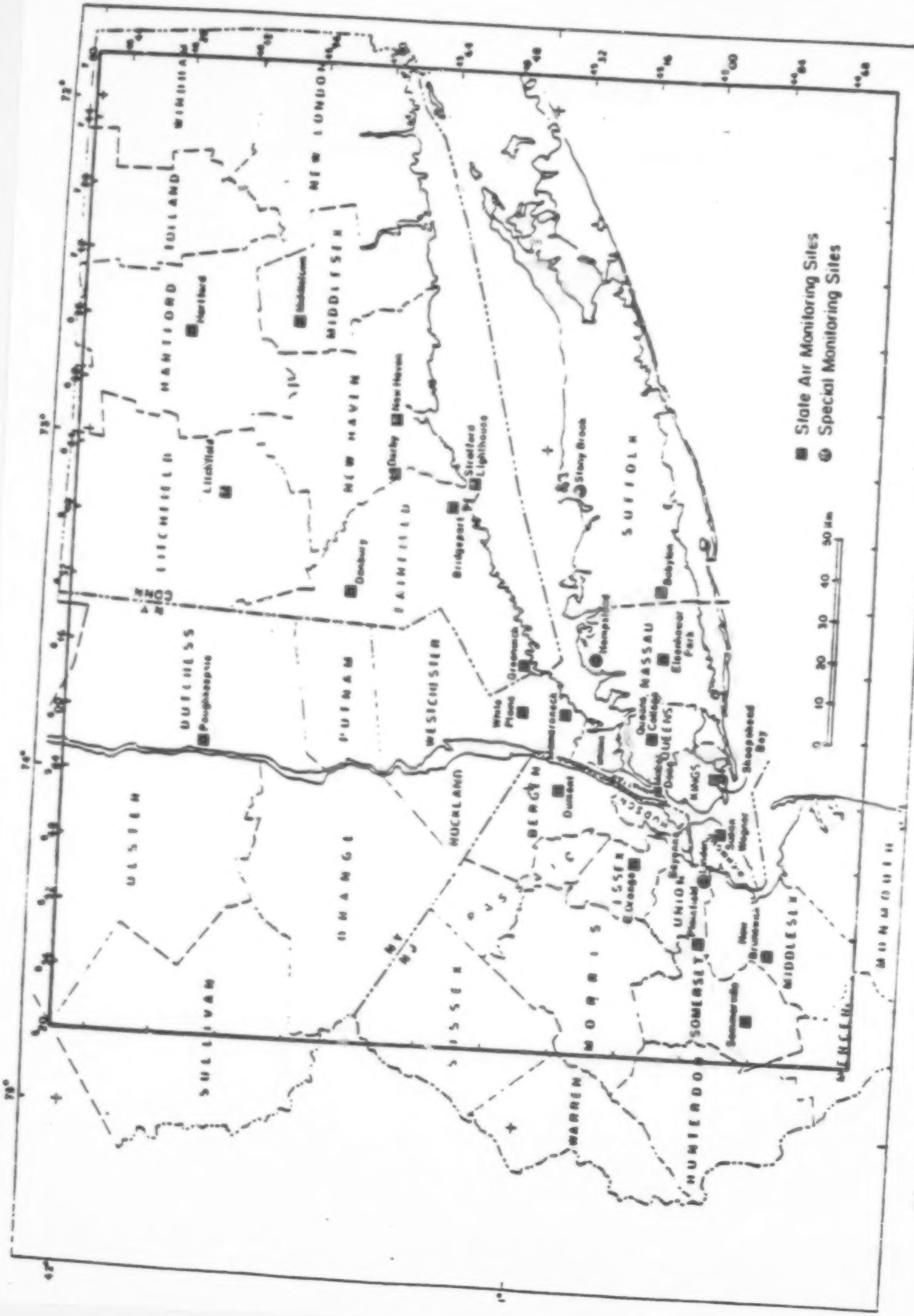
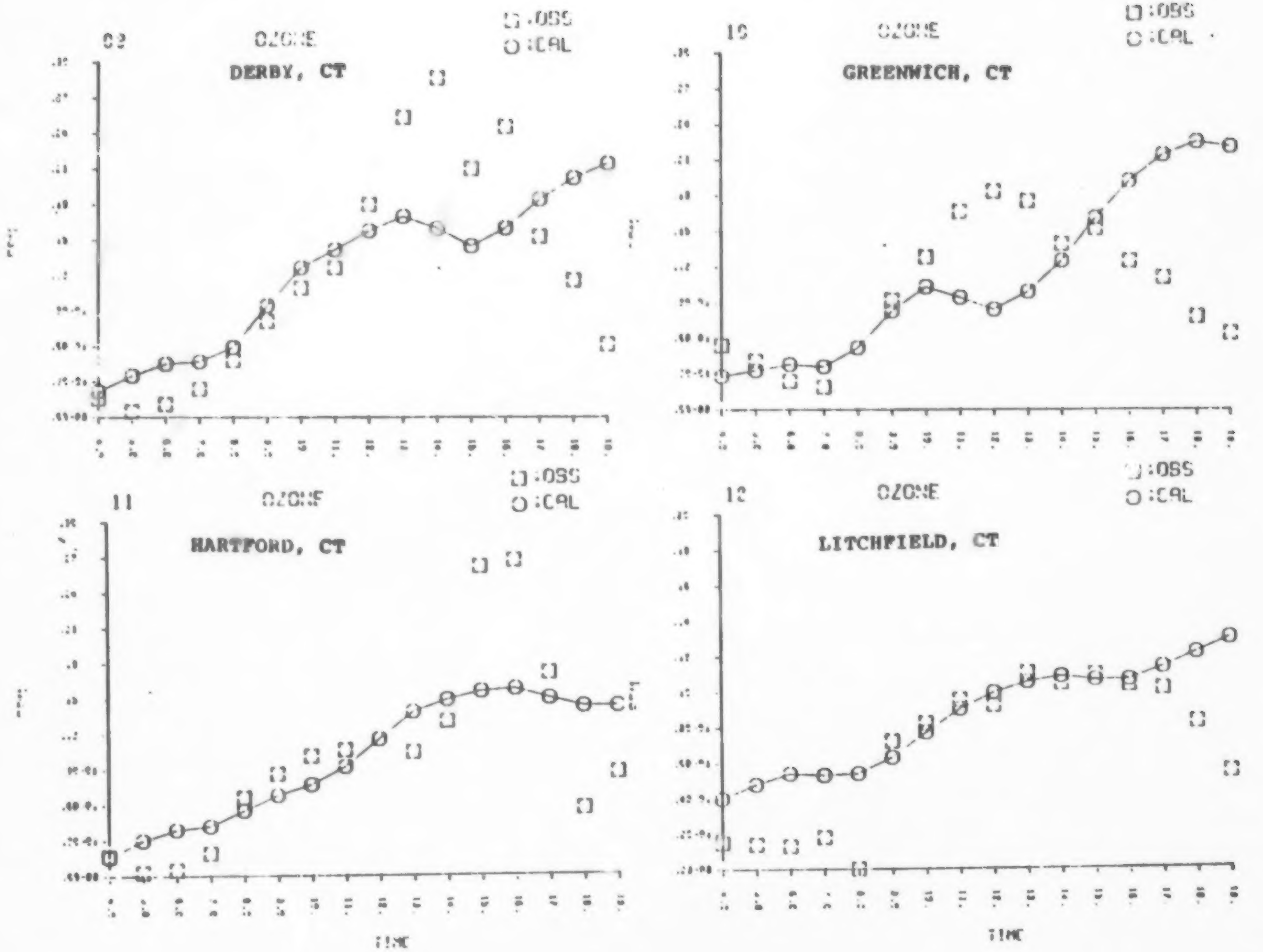
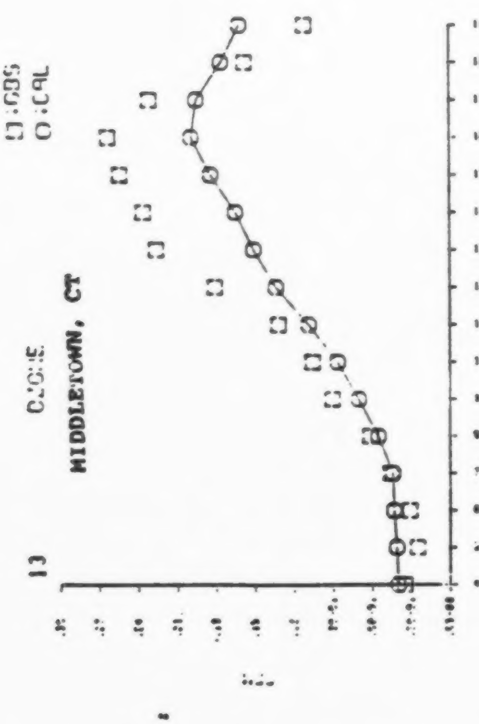

72°
73°
74°
75°
42°
41°
ULSTER
SULLIVAN
ORANGE
DUTCHESS
PUTNAM
WESTCHESTER
ROCKLAND
BERGEN
SUSSEX
WARREN
MORRIS
ESSEX
UNION
HUNTERDON
SOMERSET
MIDDLESEX
MONMOUTH
MERCER
LITCHFIELD
HARTFORD
TOLLAND
WINDHAM
NEW LONDON
MIDDLESEX
NEW HAVEN
FAIRFIELD
SUFFOLK
NASSAU
QUEENS
KINGS
NY
CONN
NY
NJ
Poughkeepsie
Hartford
Middletown
Litchfield
Derby
New Haven
Stratford Lighthouse
Bridgeport
Danbury
Greenwich
White Plains
Mamaroneck
Dumont
Stony Brook
Babylon
Hempstead
Eisenhower Park
Queens College
Sheepshead Bay
Bayonne
New Brunswick
0 10 20 30 40 50 Km
State Air Monitoring Sites
Special Monitoring Sites

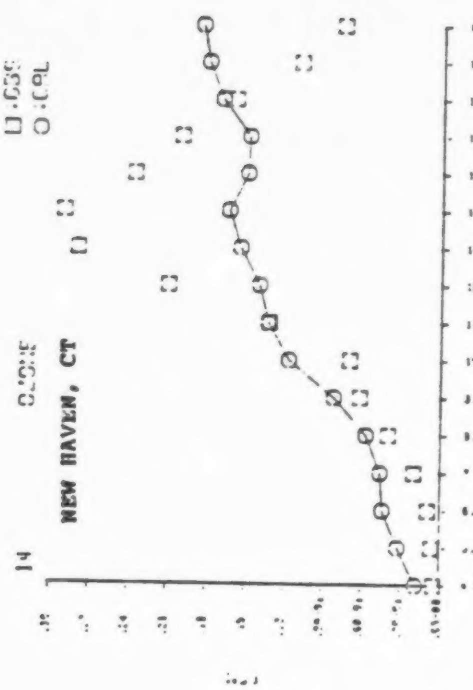
Figure B-1 Location of the routine and special monitoring sites for Ozone

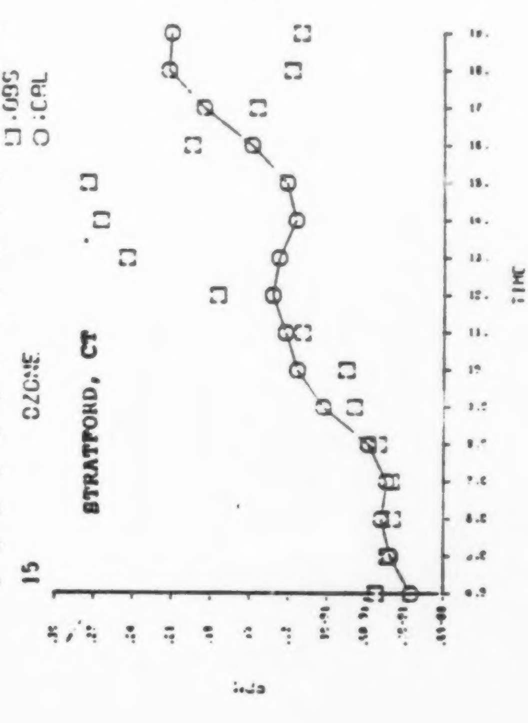
3-2 Diurnal Plots of the observed and predicted ozone concentrations at monitoring stations on JD80198(071680).

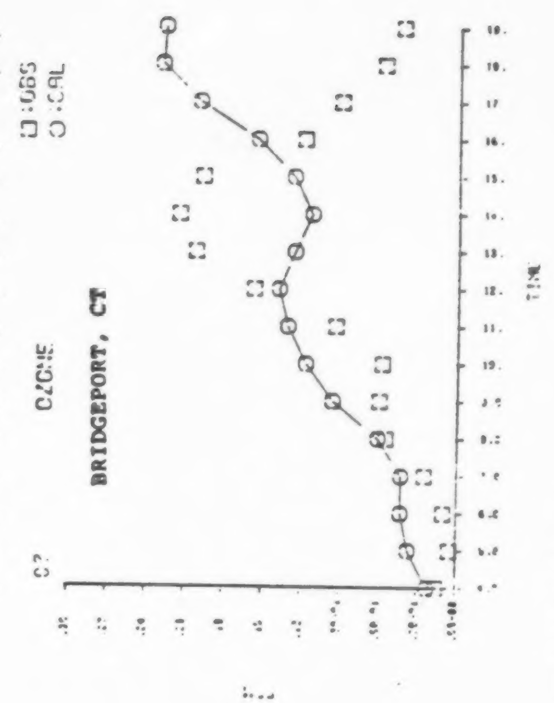


JD80198 (071680)

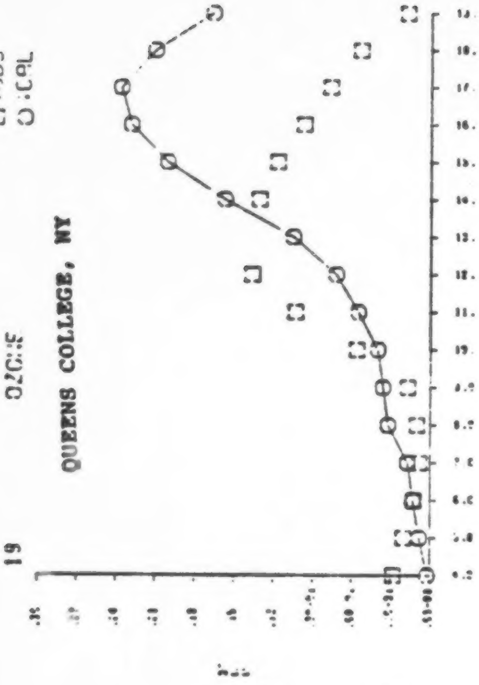


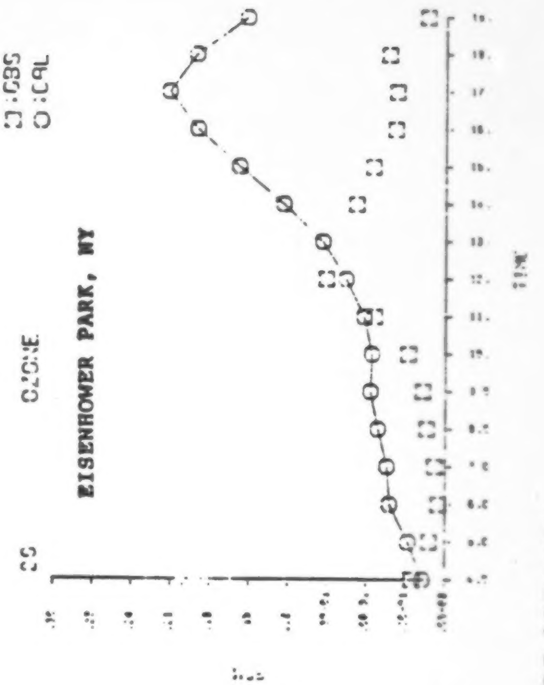


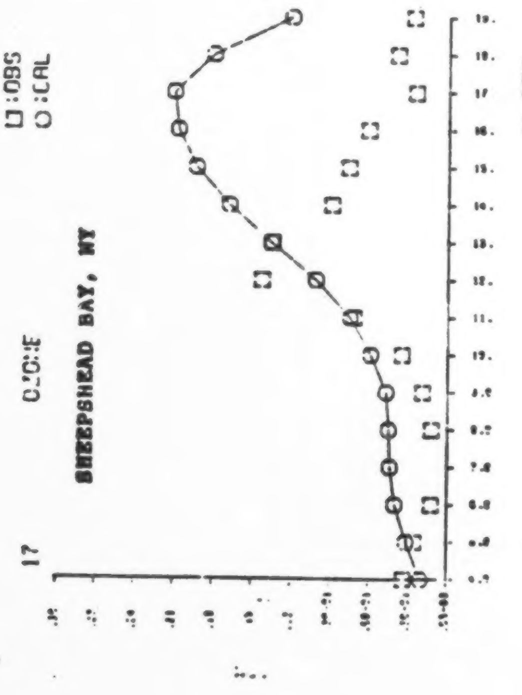


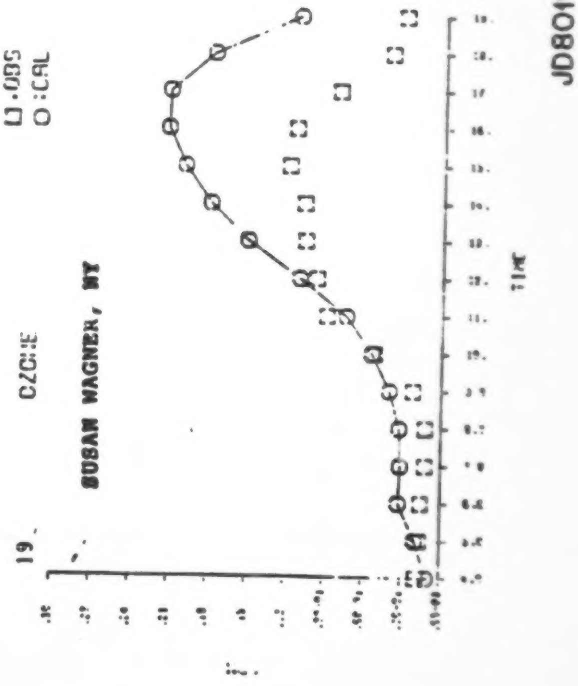


JD80198 (071680)









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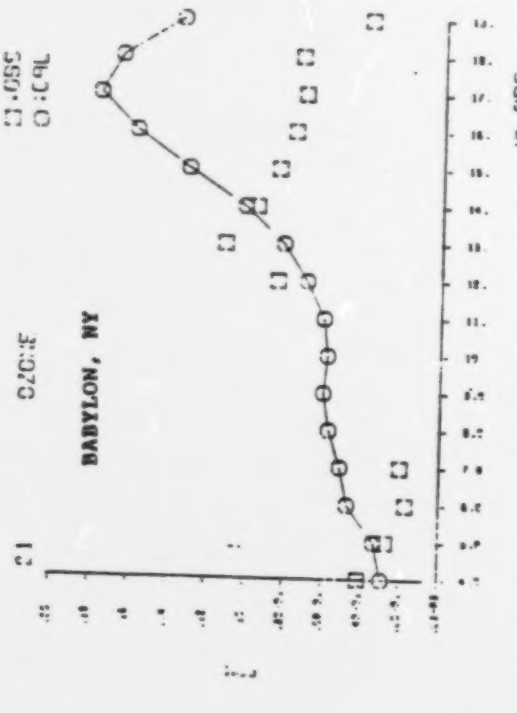

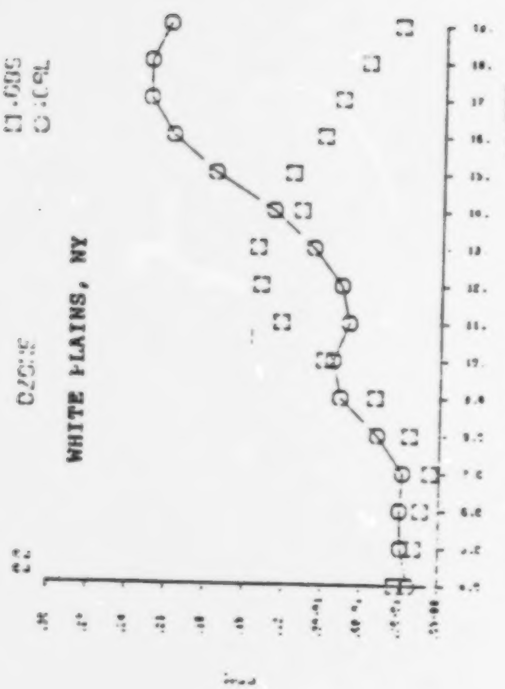

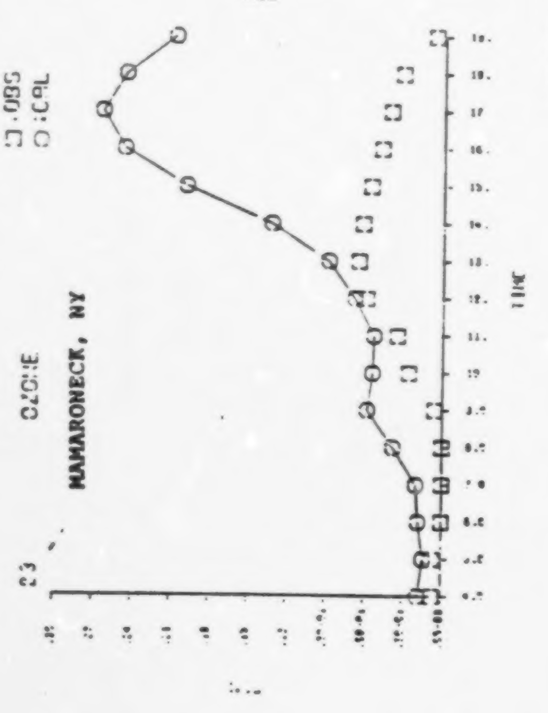

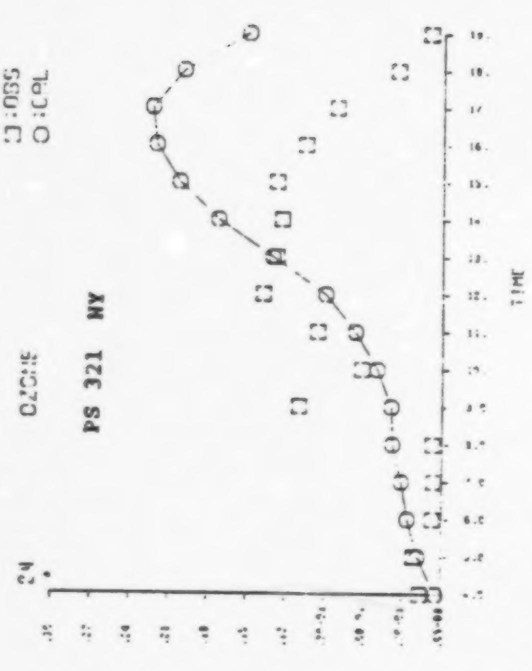

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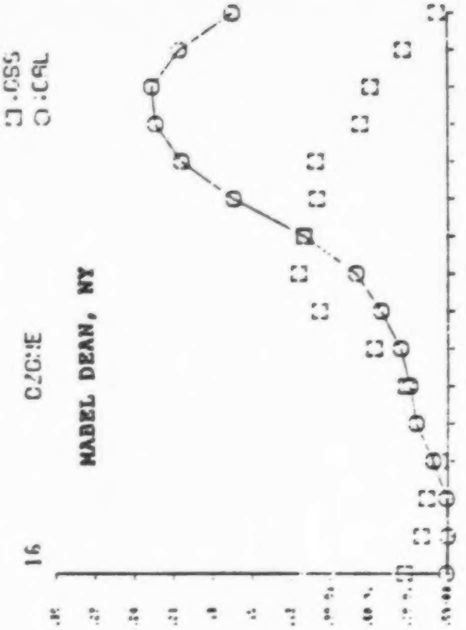

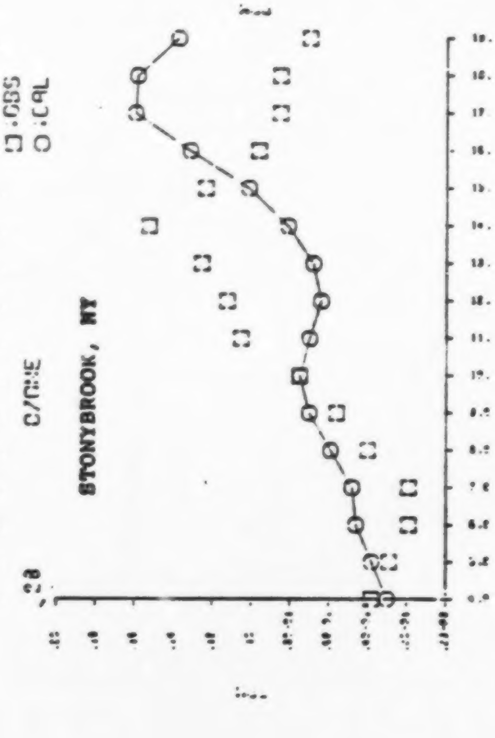

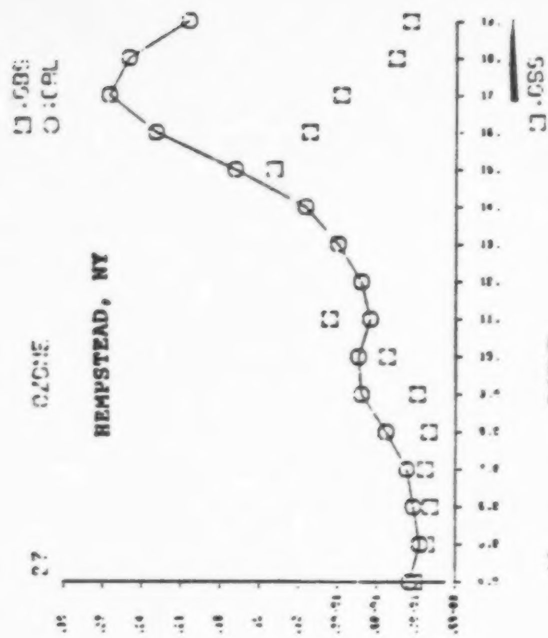

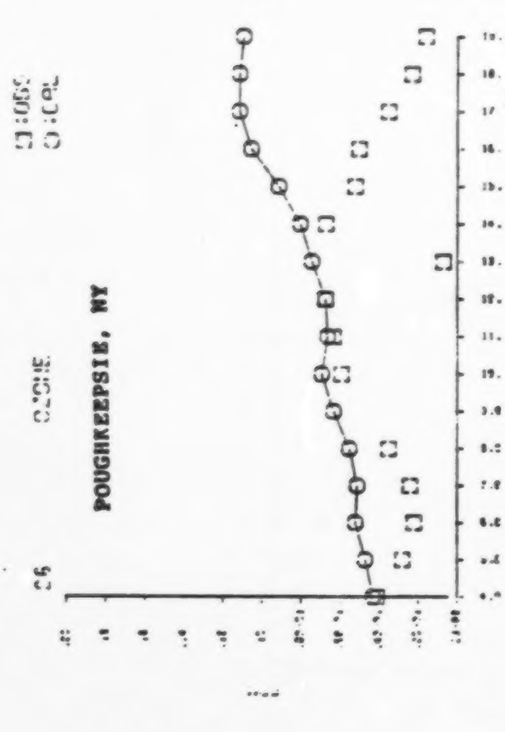

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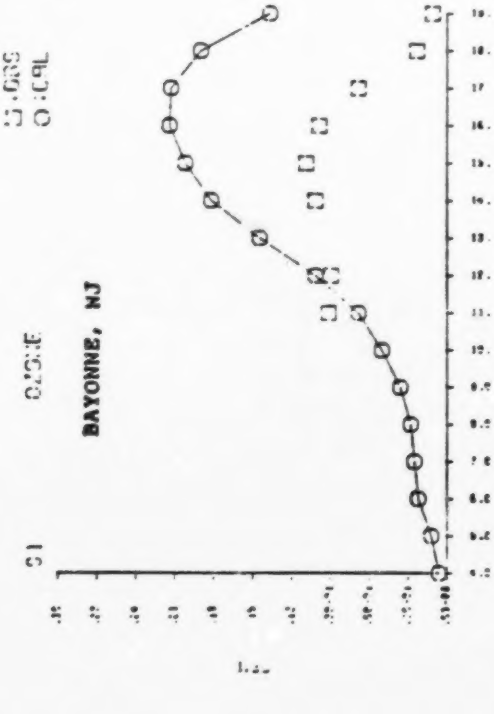

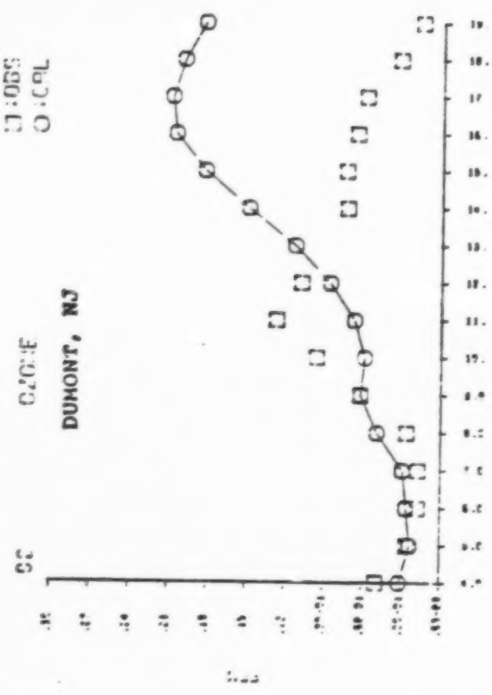

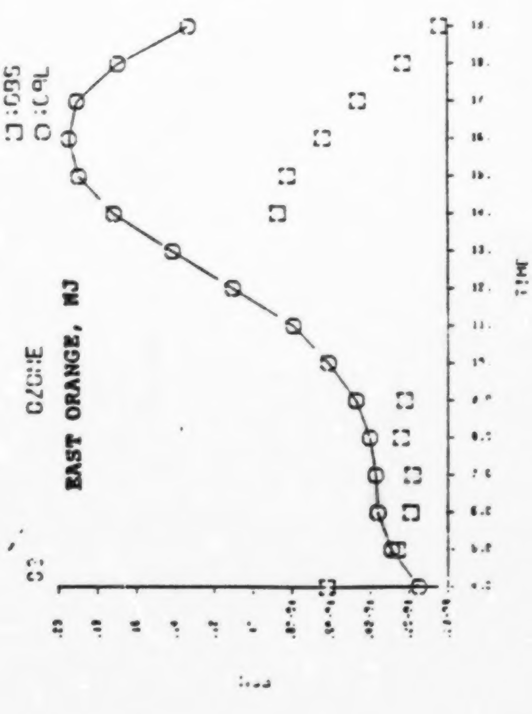

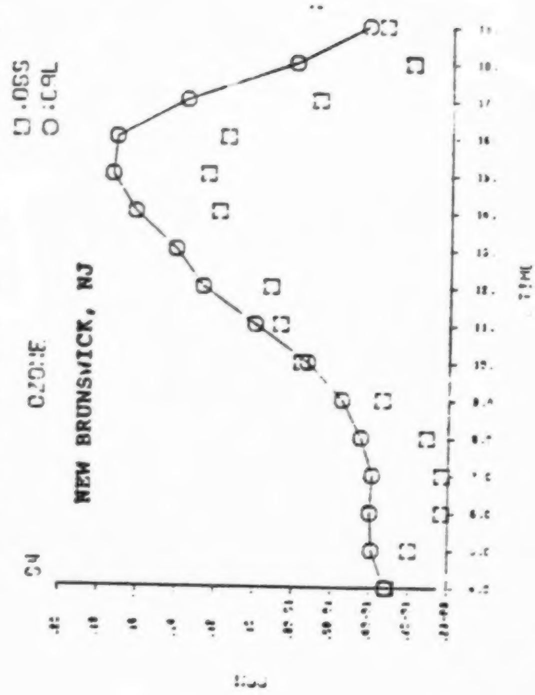

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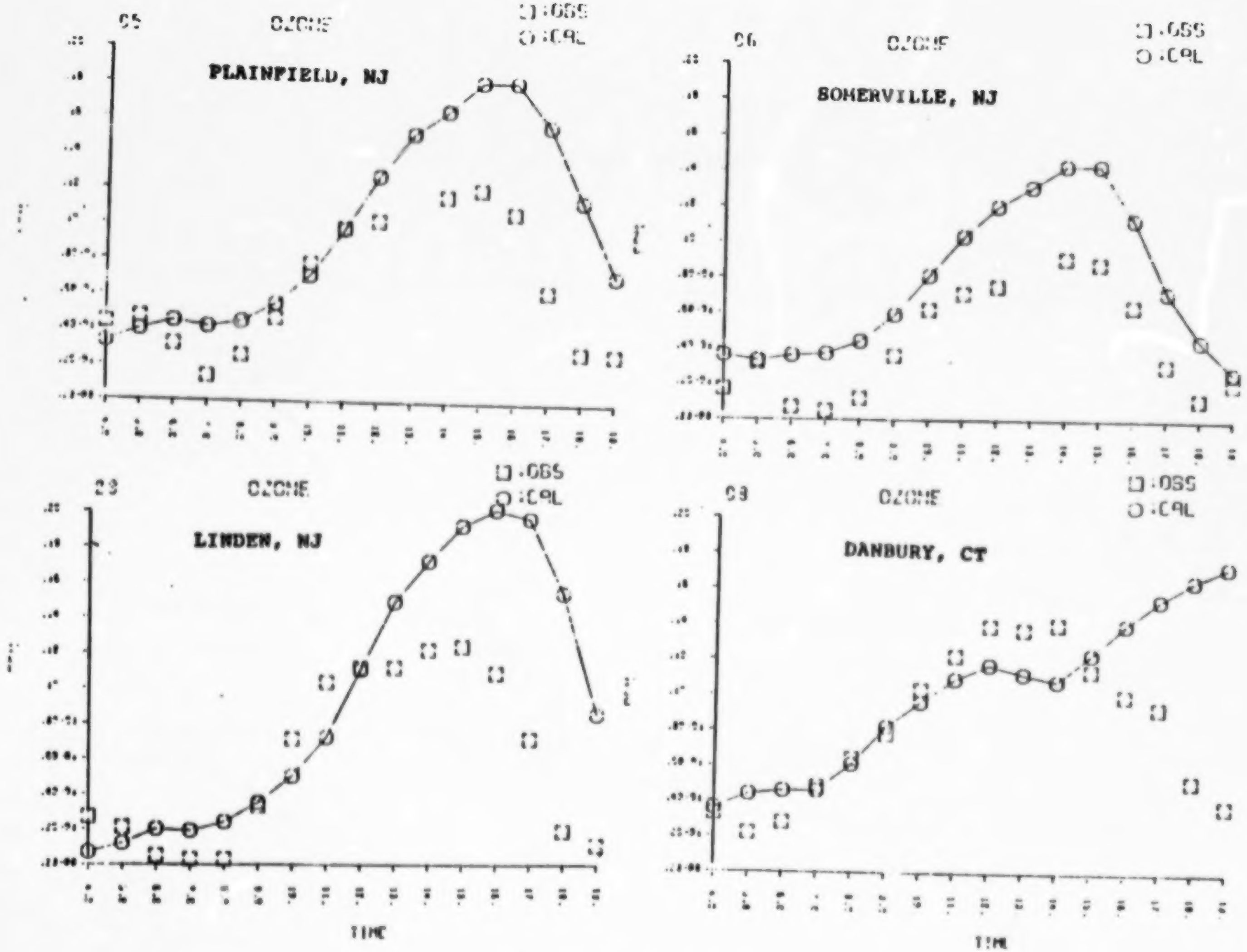
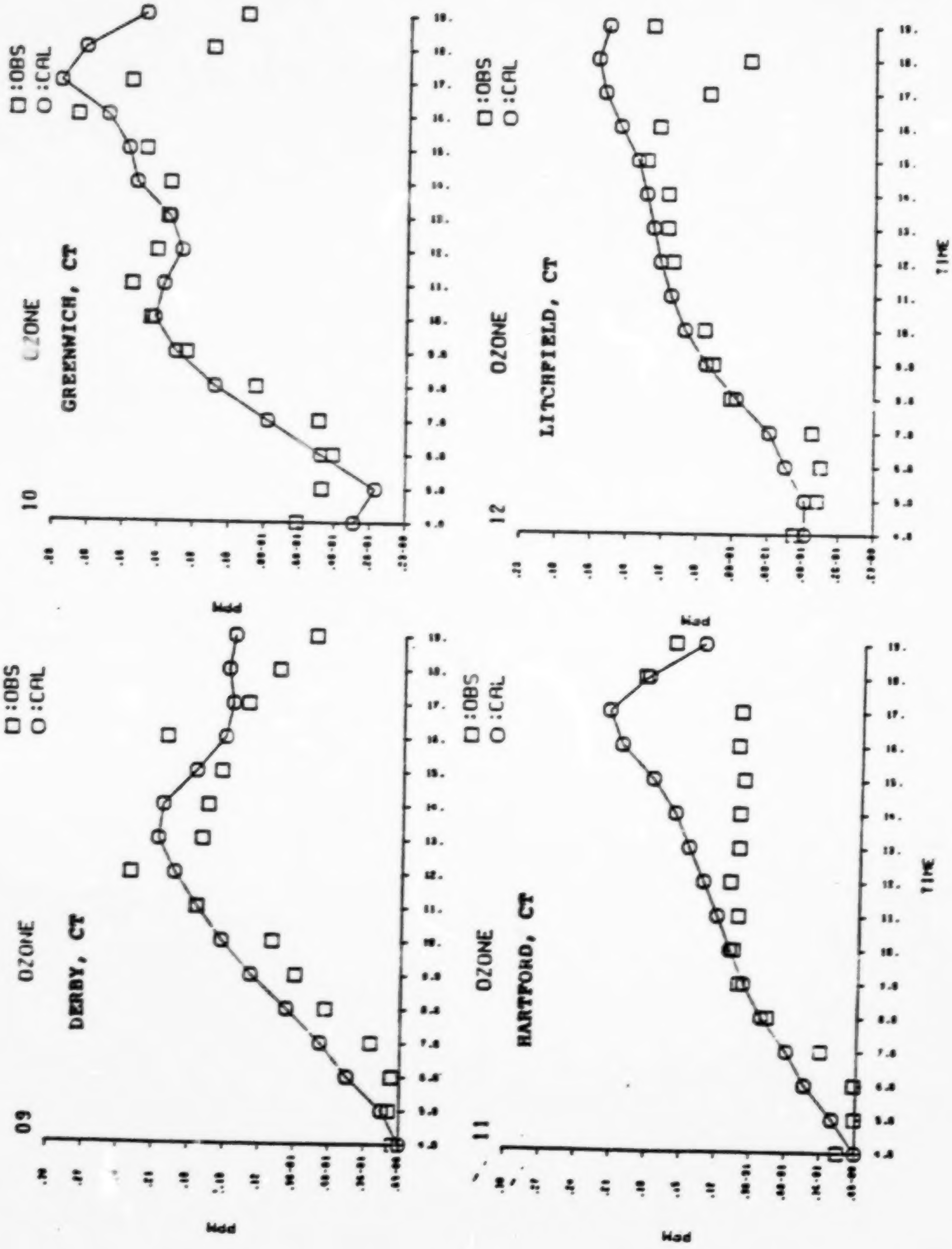


JD80198 (071680)

B-3 Diurnal Plots of the observed and predicted ozone concentrations at monitoring stations on JD80203(072180).



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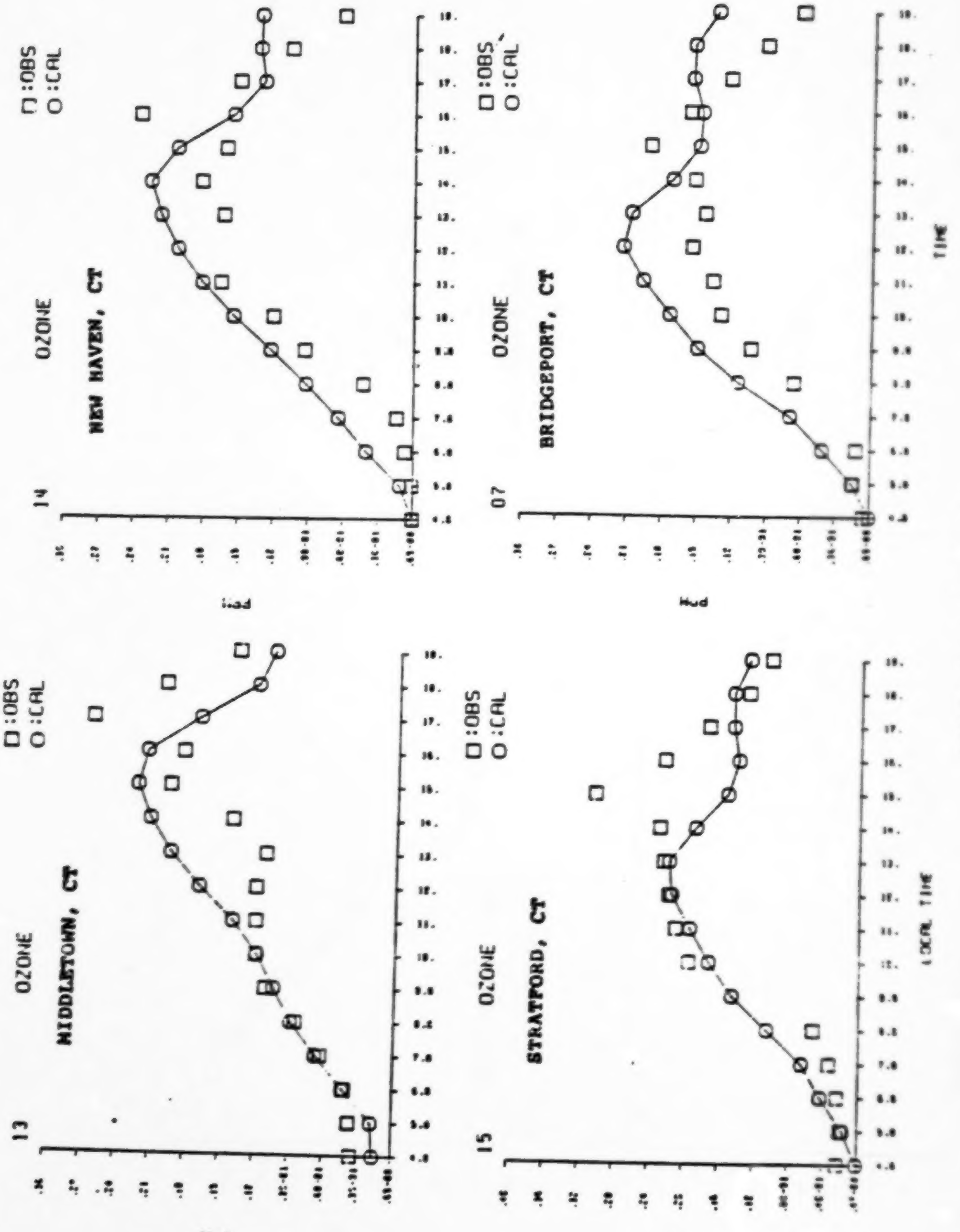

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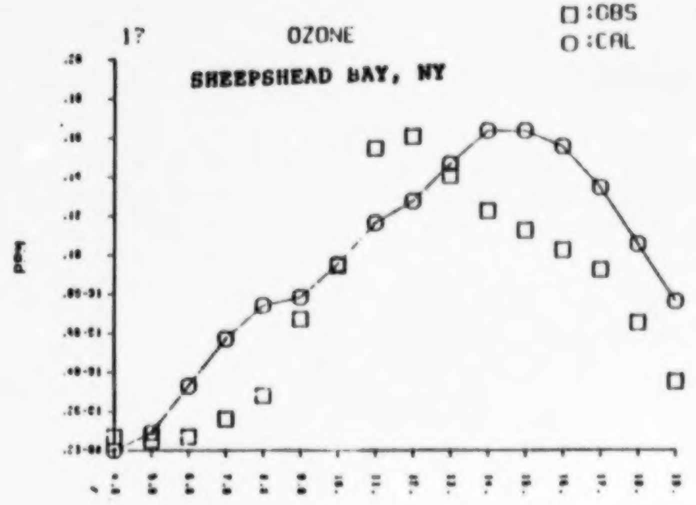

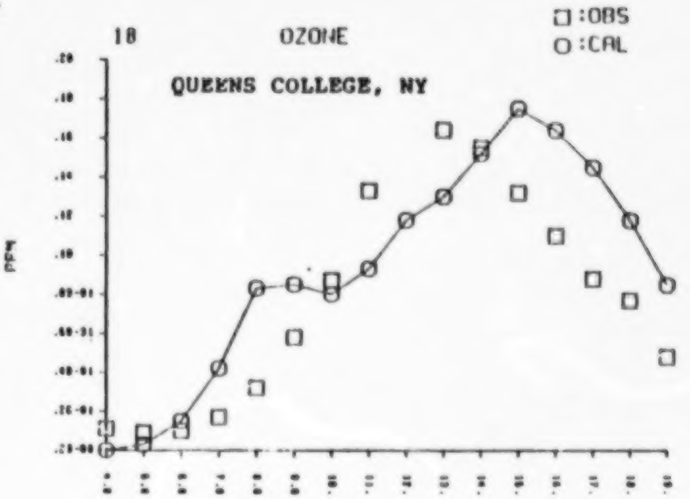

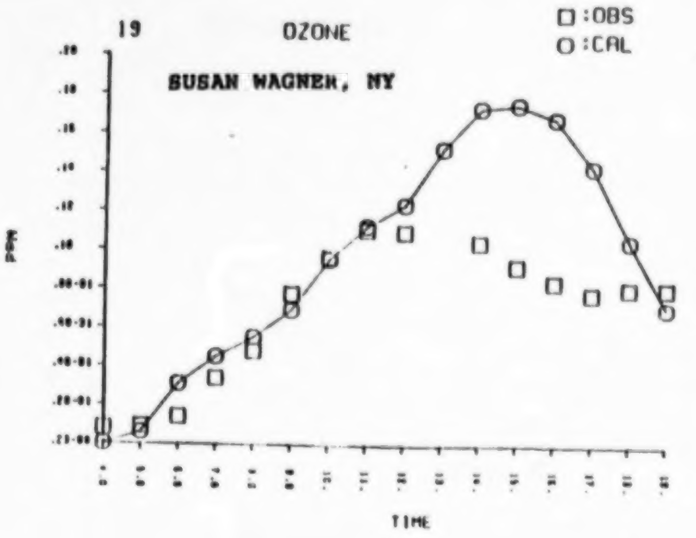

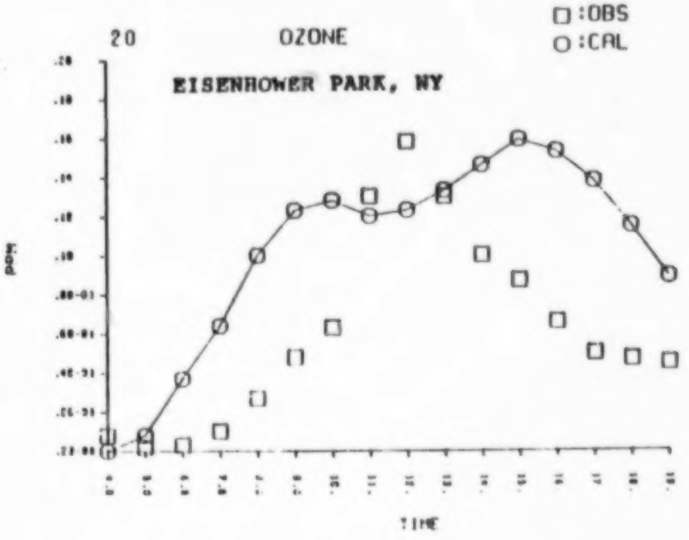

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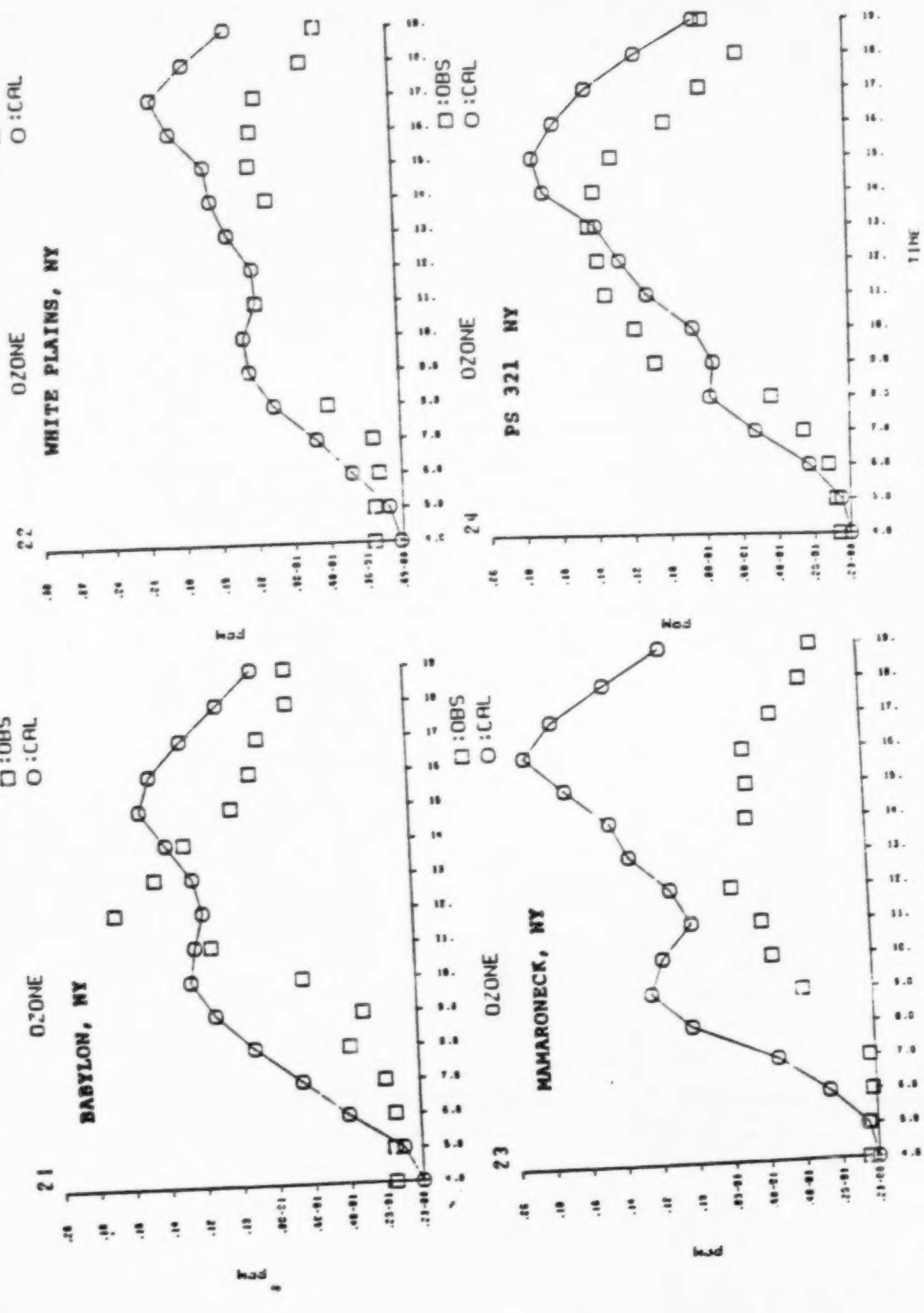

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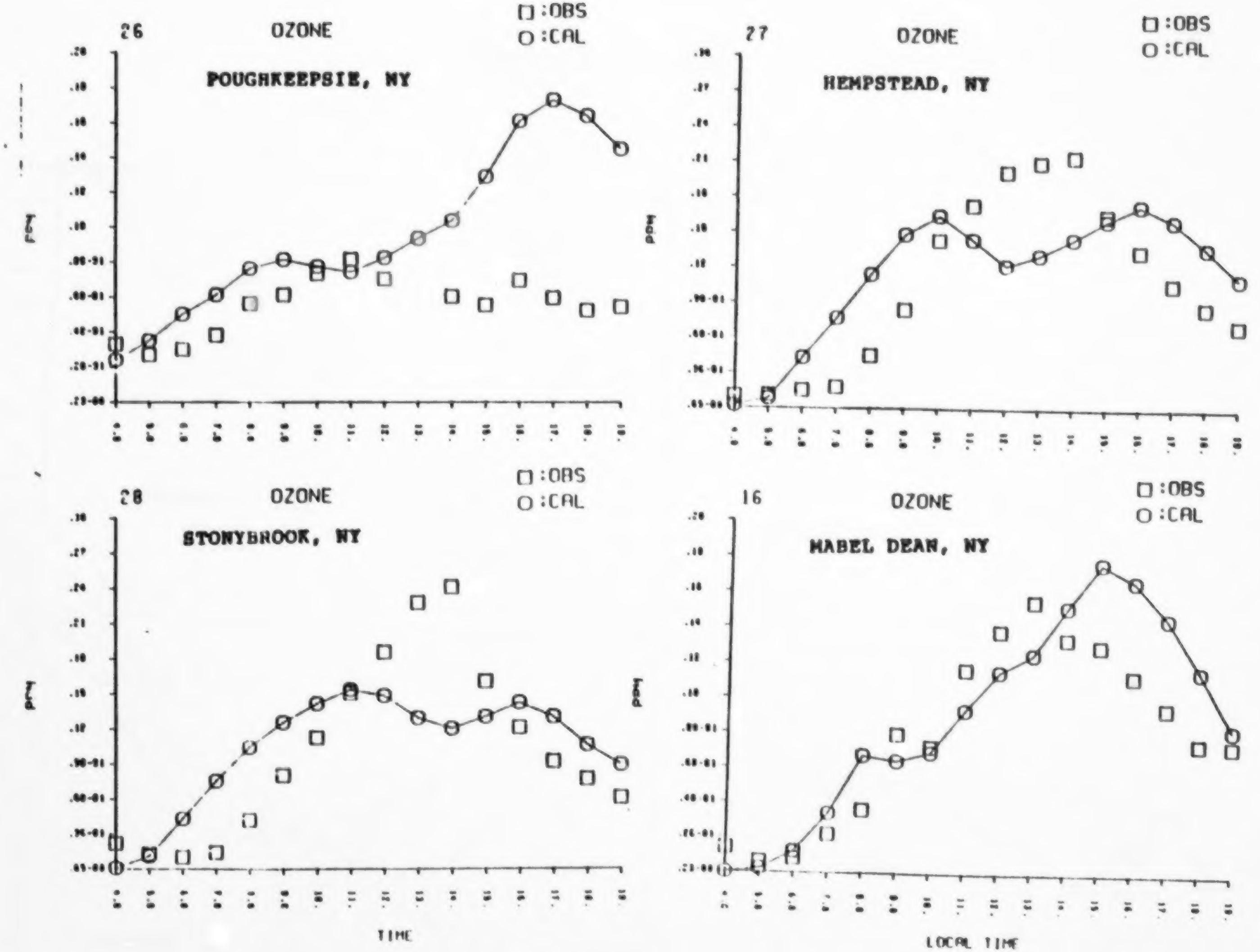

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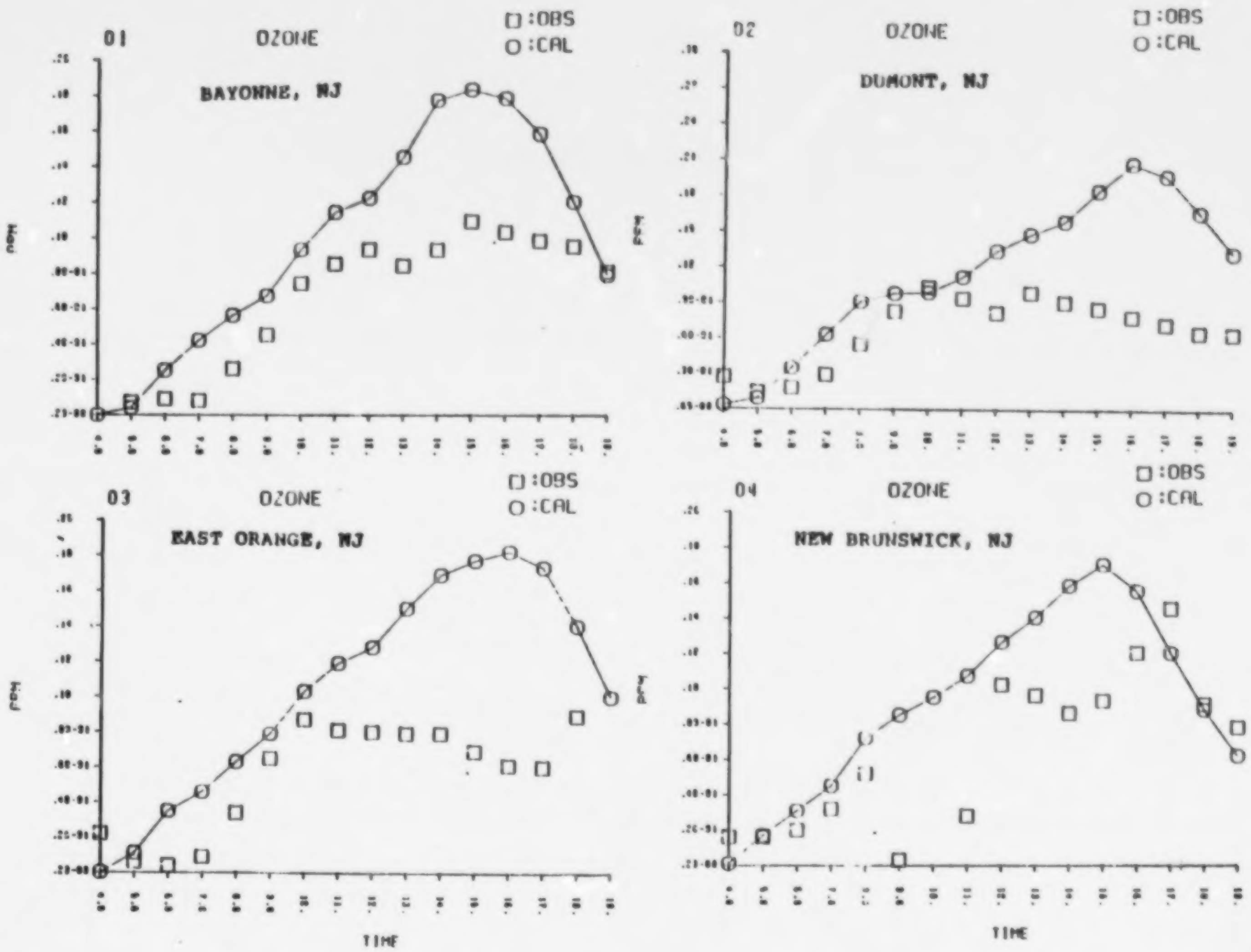

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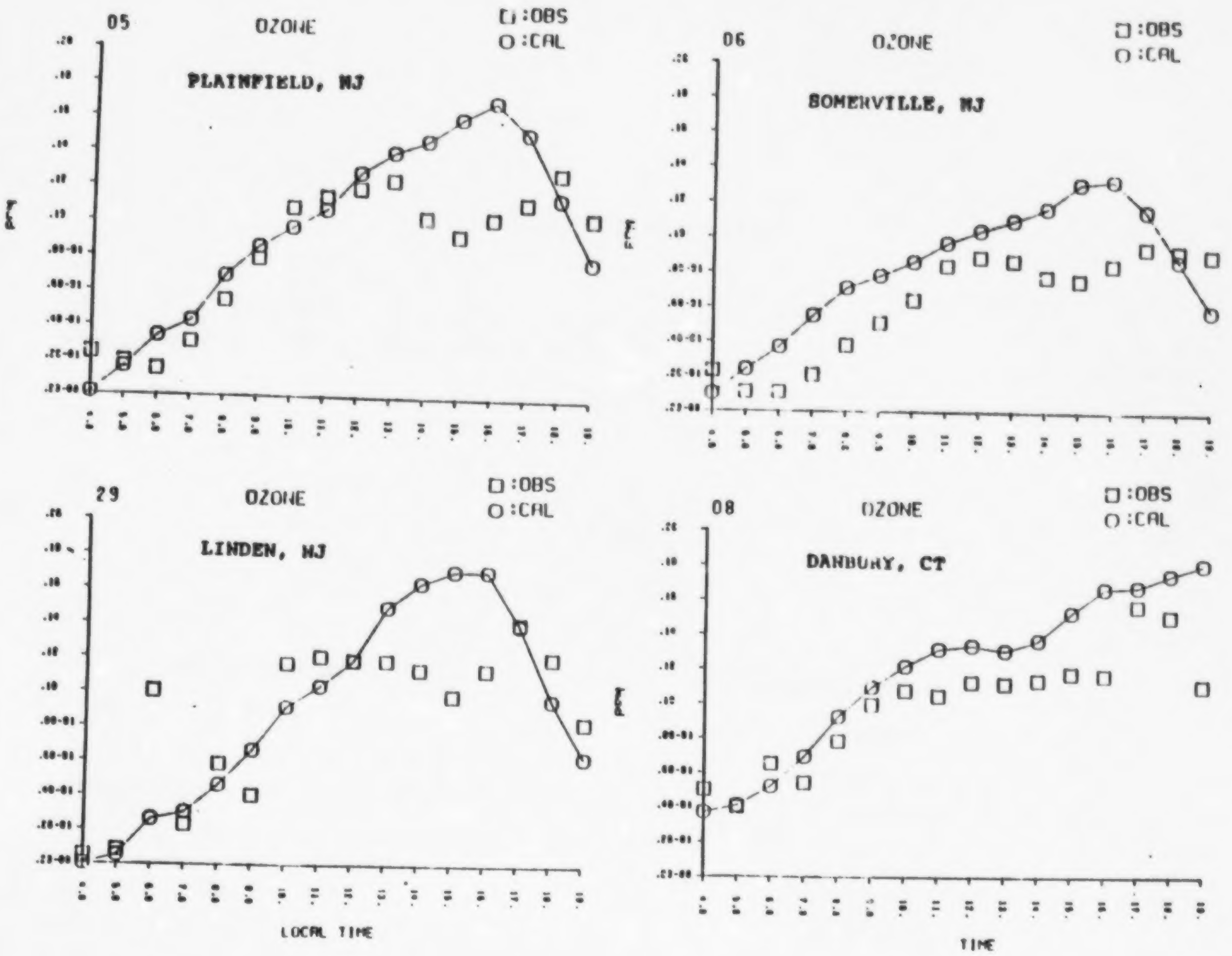
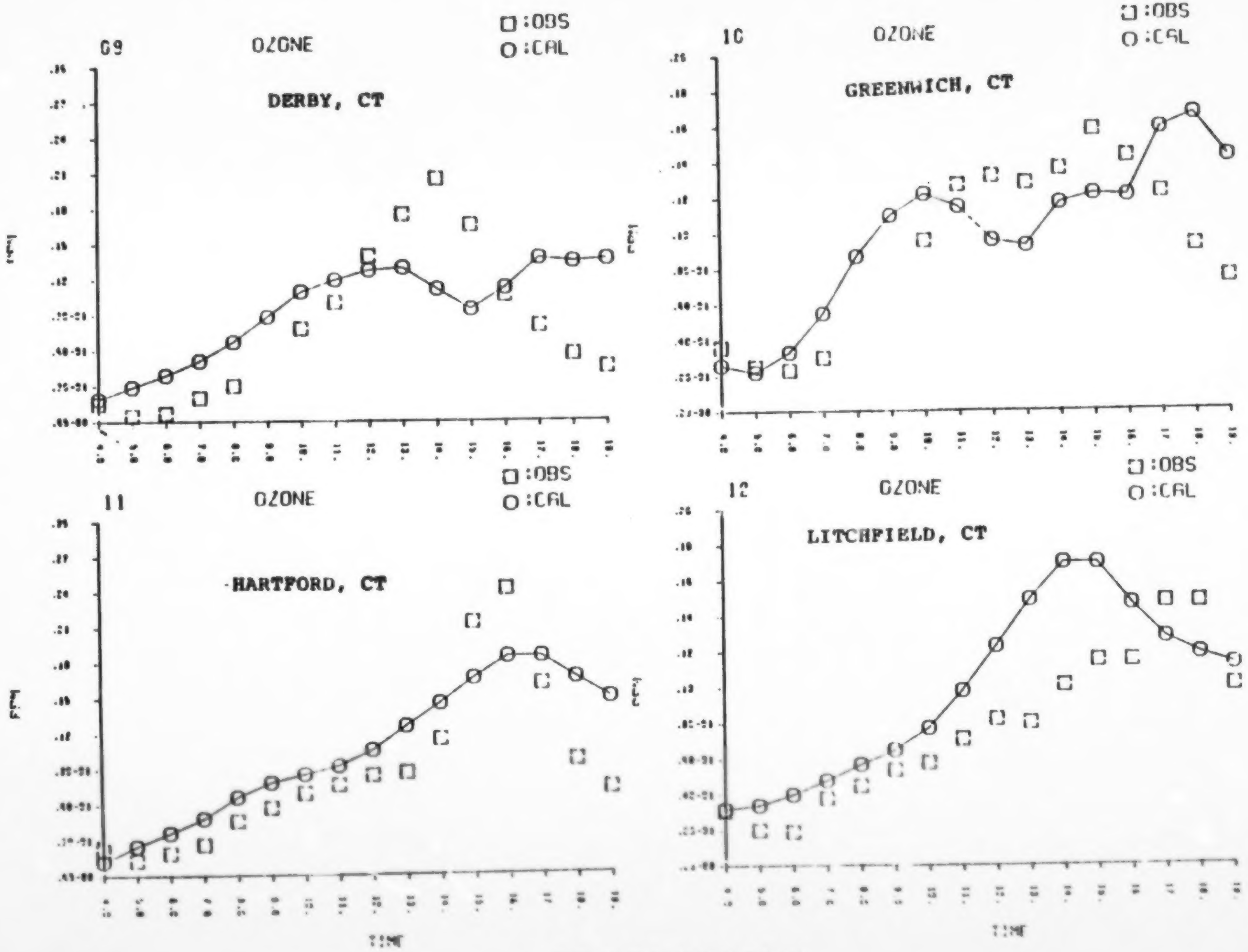


JD80203 (072180)

B-4 Diurnal Plots of the observed and predicted ozone concentrations at monitoring stations on JD80204(072280).



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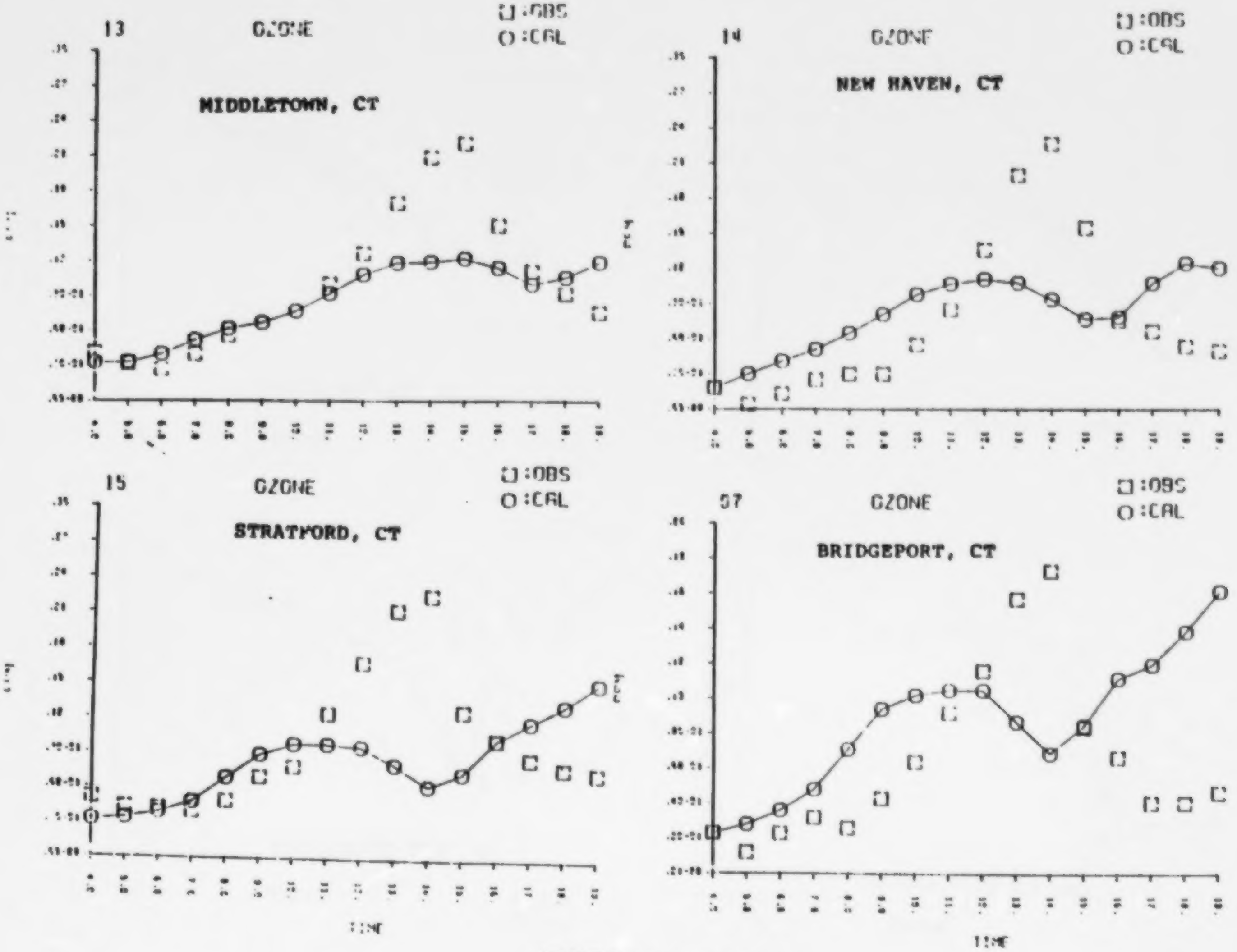

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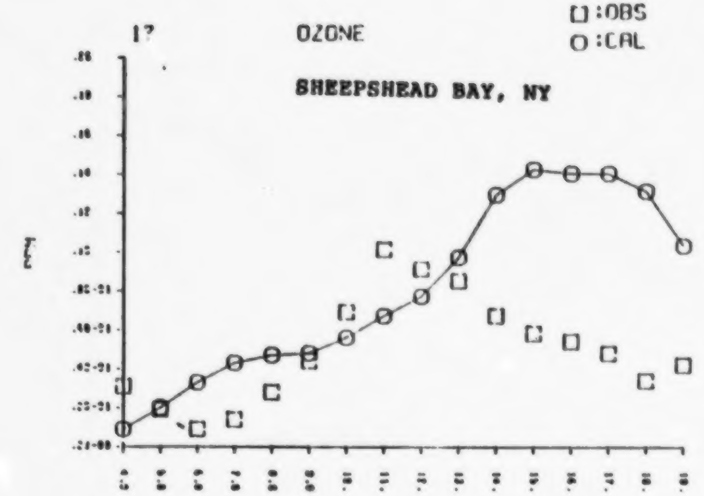

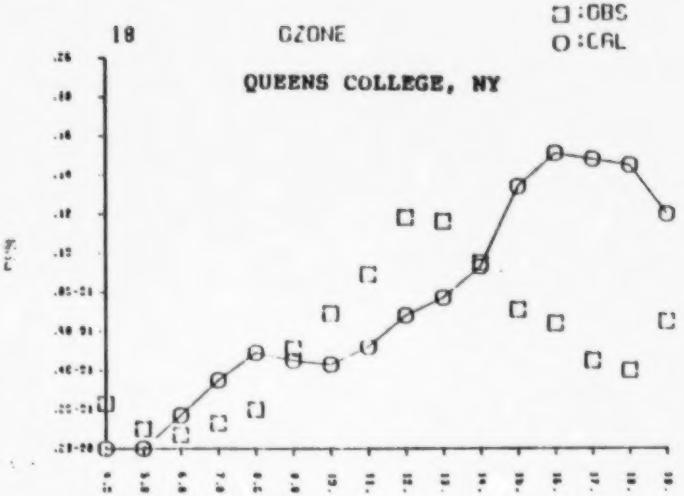

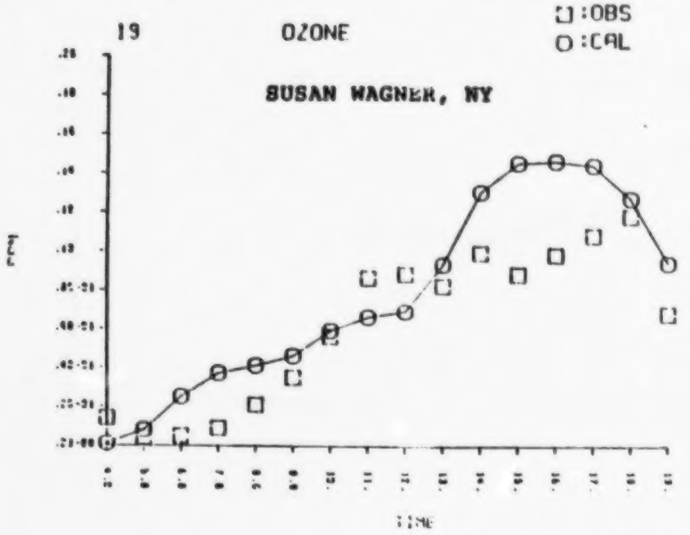

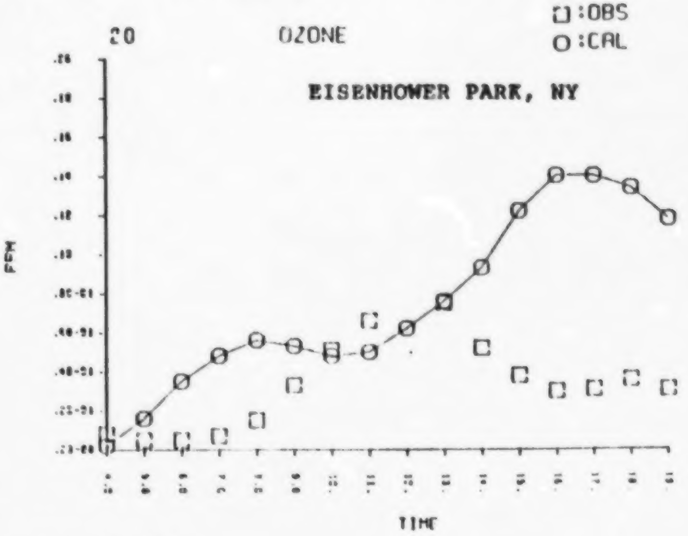

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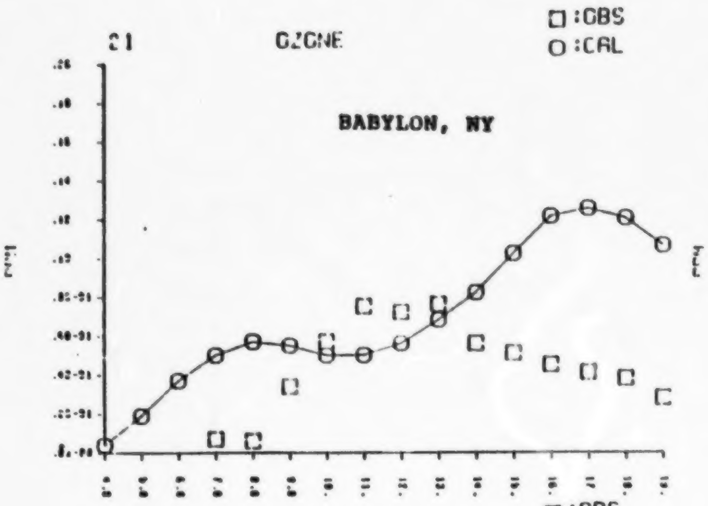

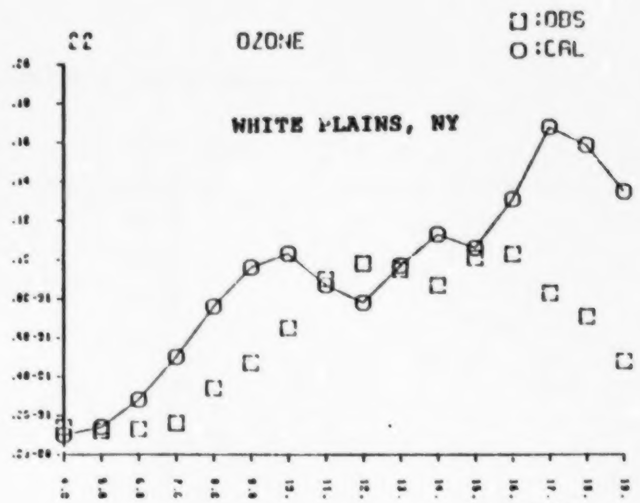

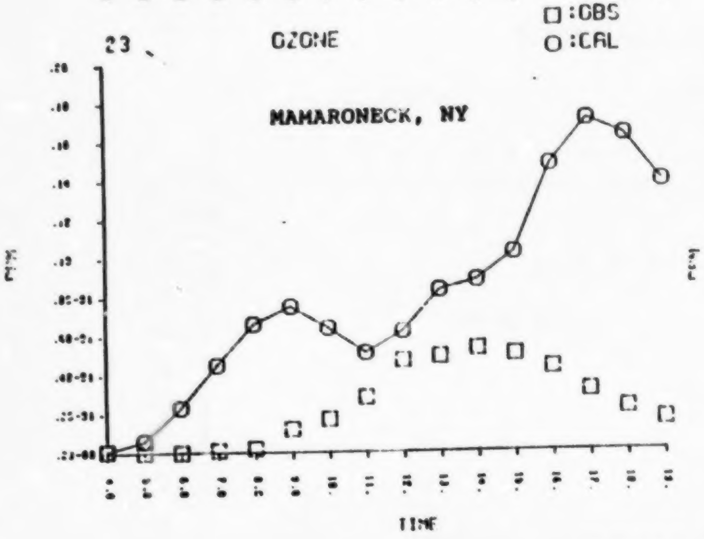

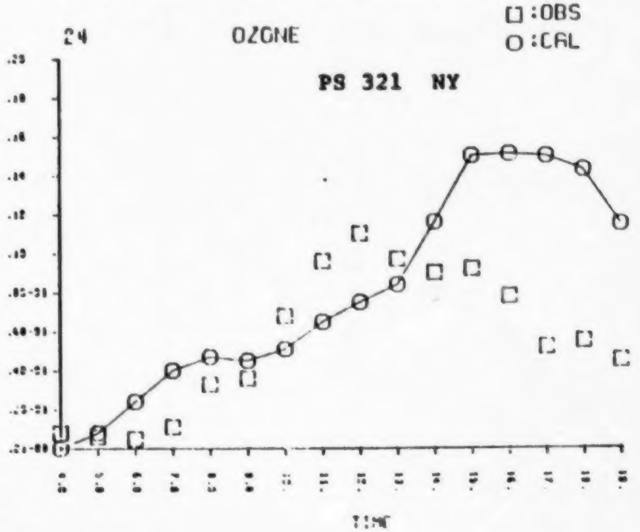

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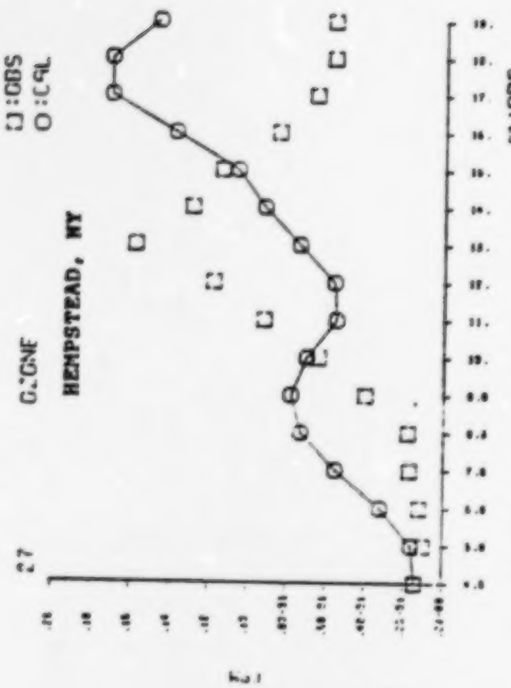

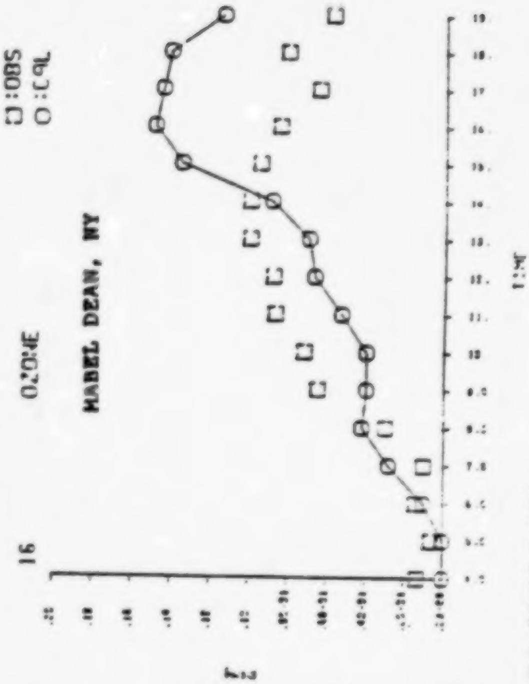

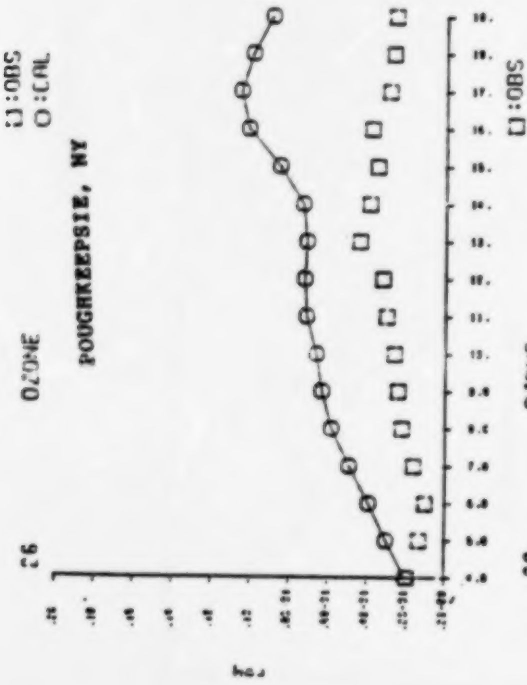

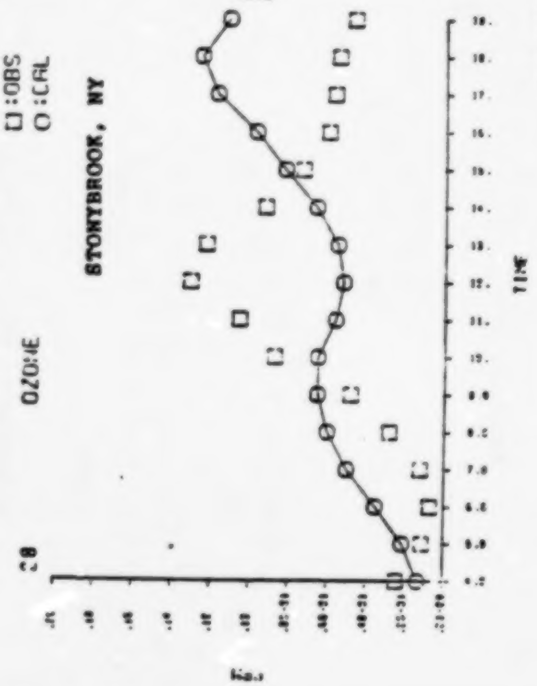

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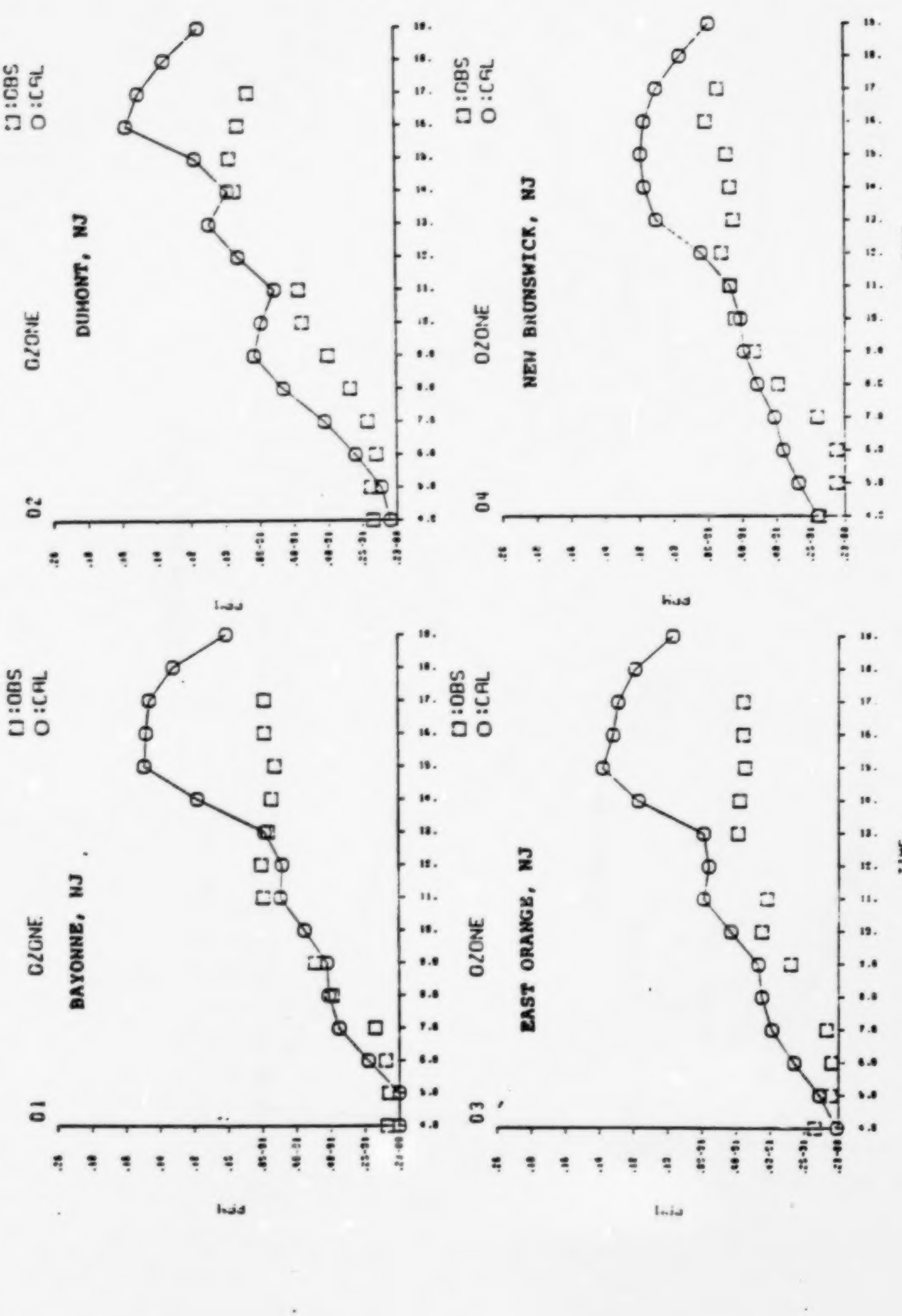

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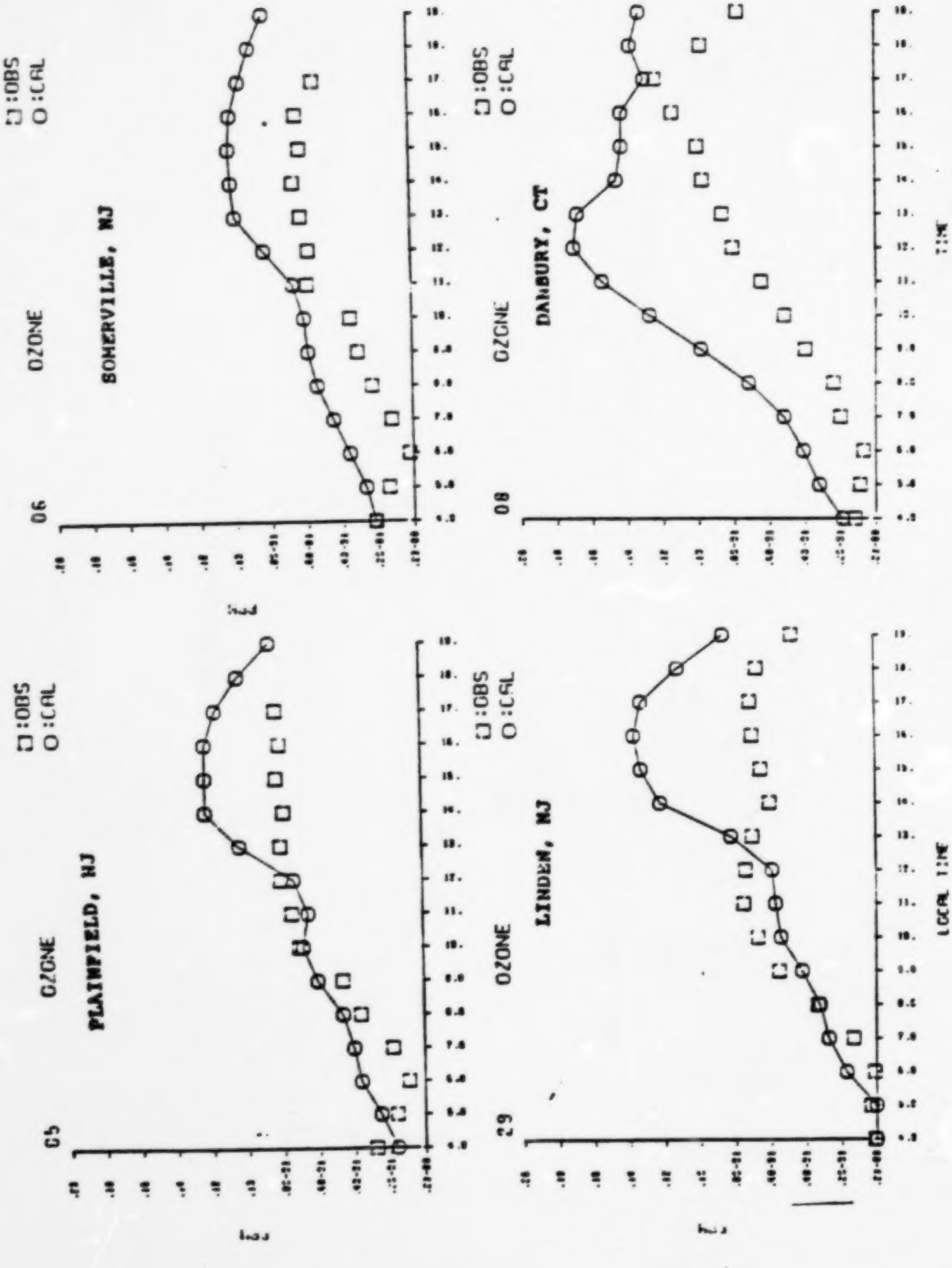
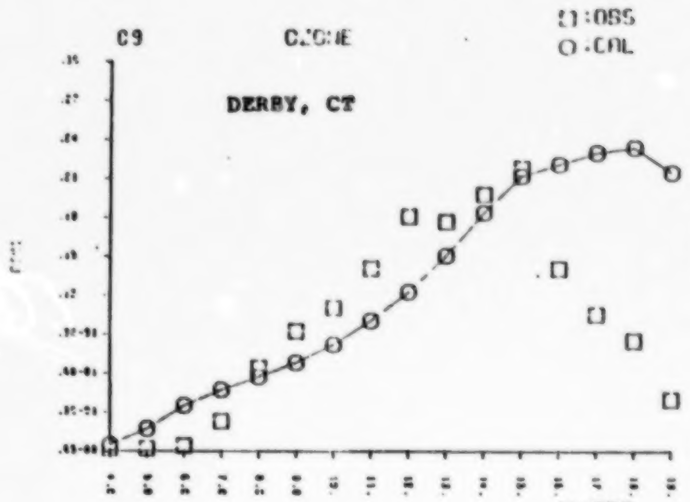
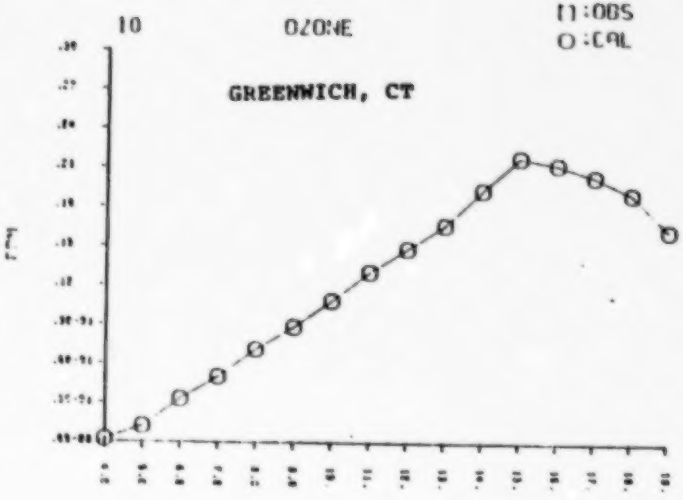
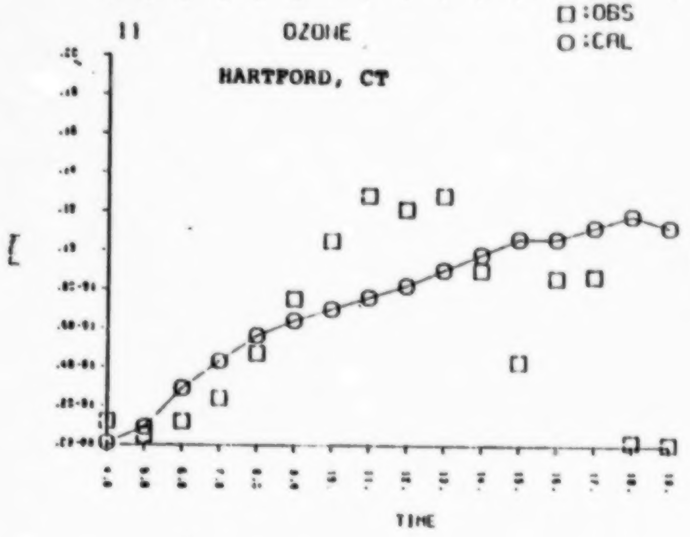


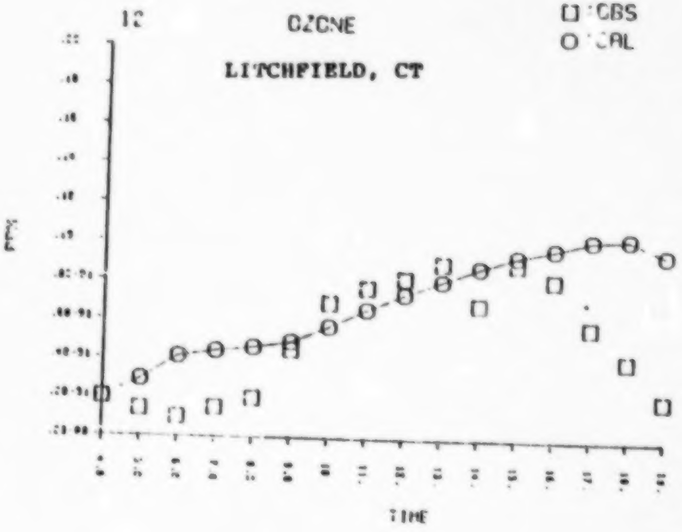
JD80204 (072280)

B-5 Diurnal Plots of the observed and predicted ozone concentrations at monitoring stations on JD80219(080680).

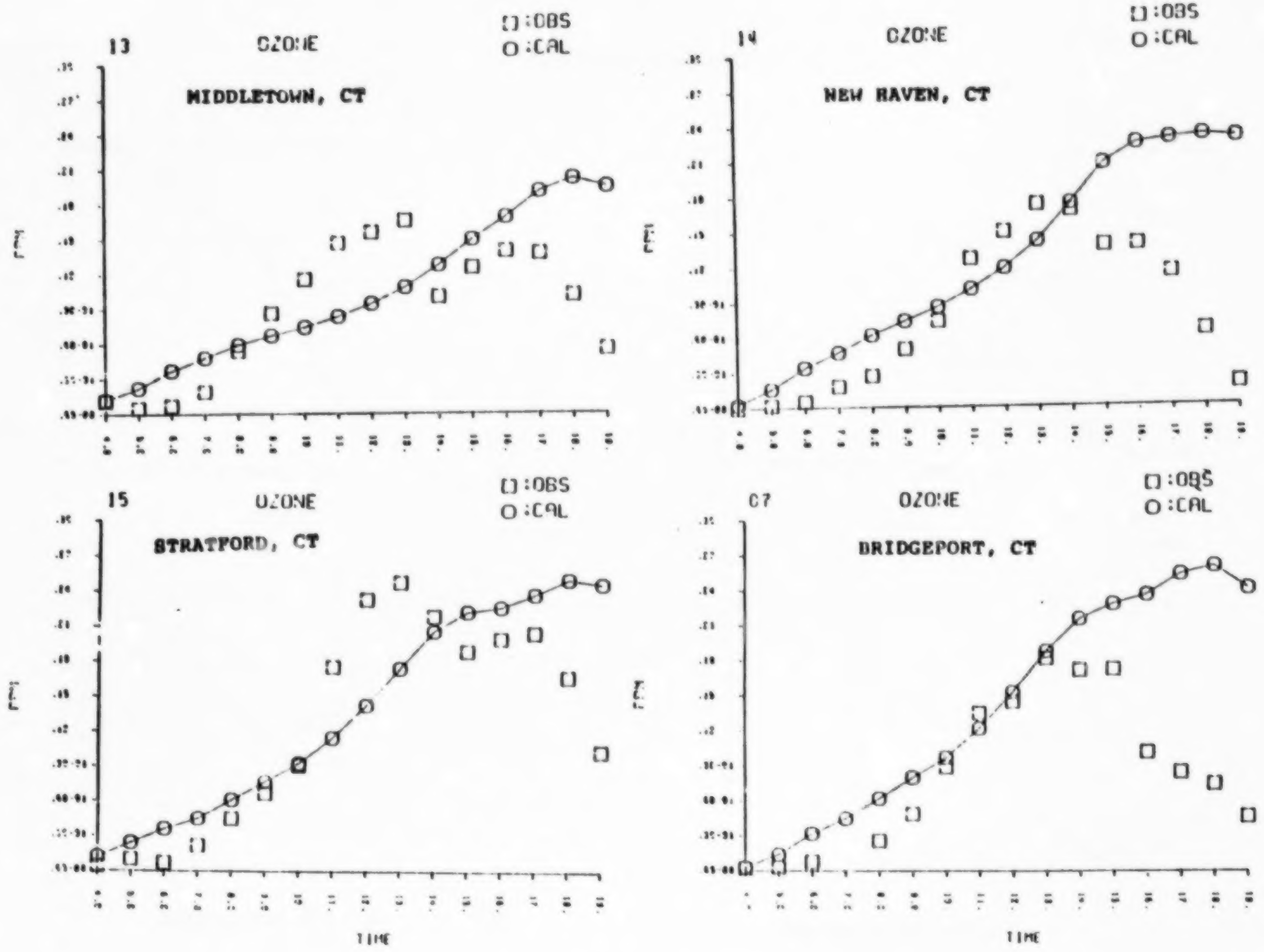








JD80219 (080680)



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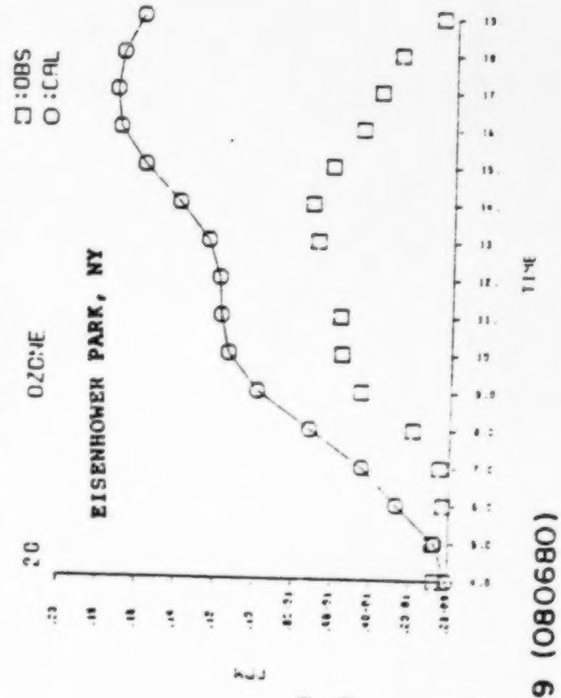

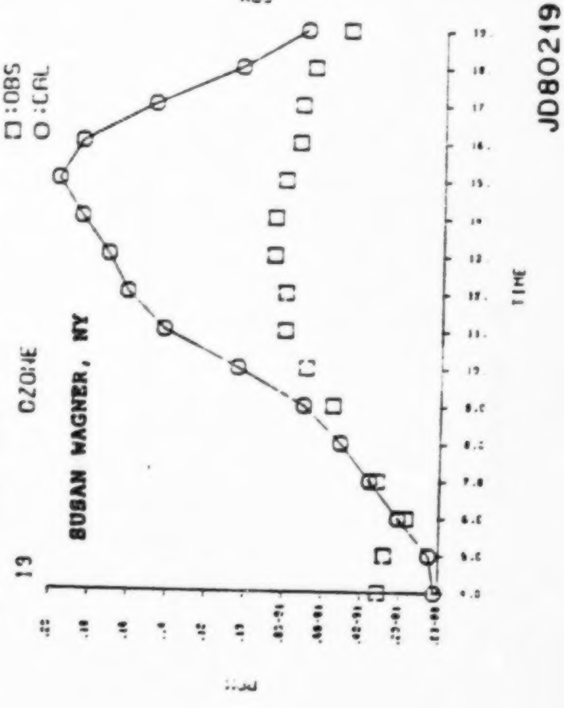

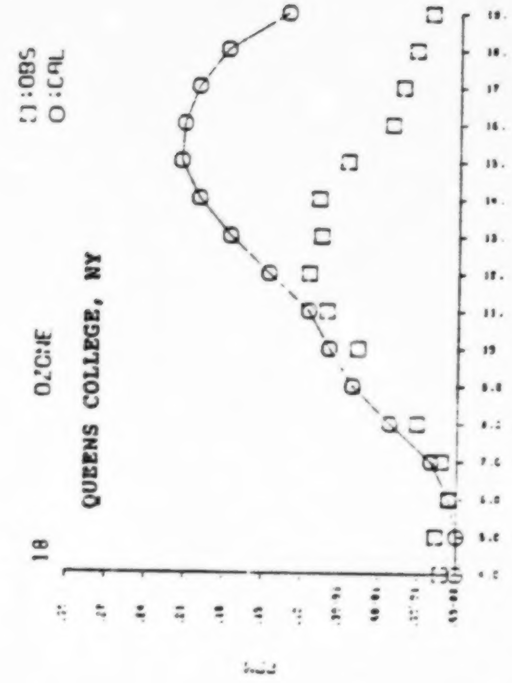

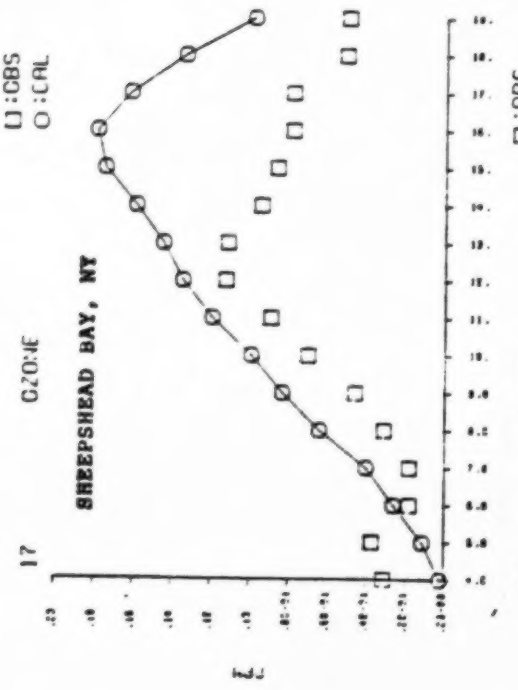

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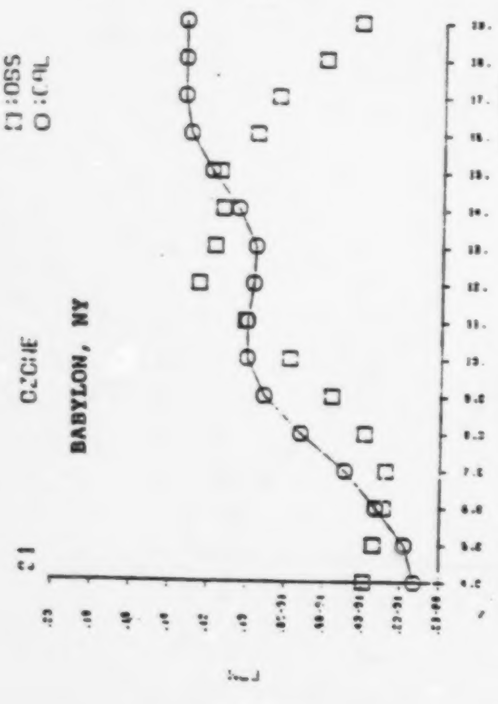

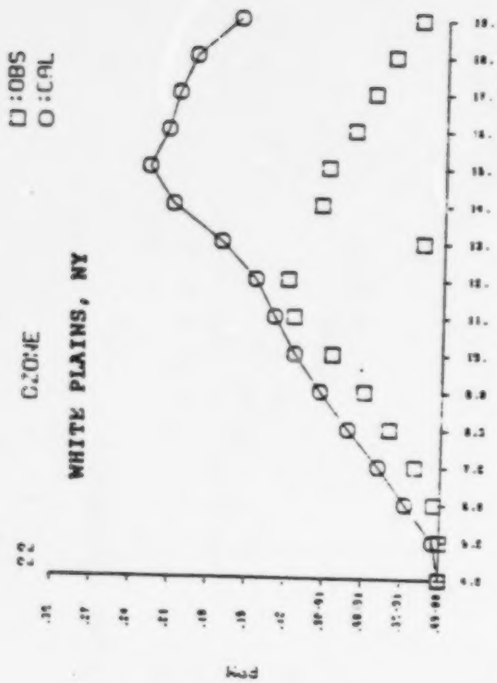

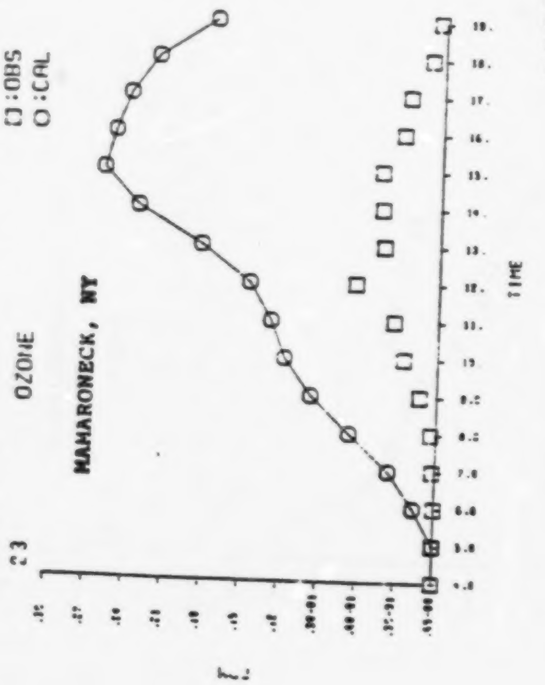

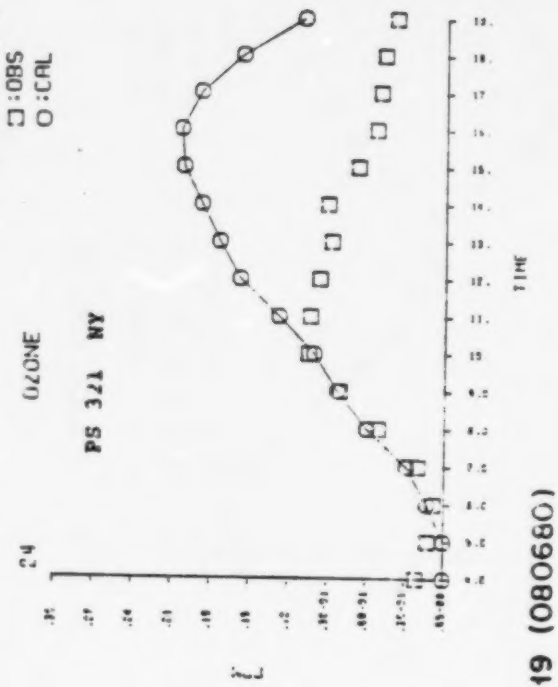

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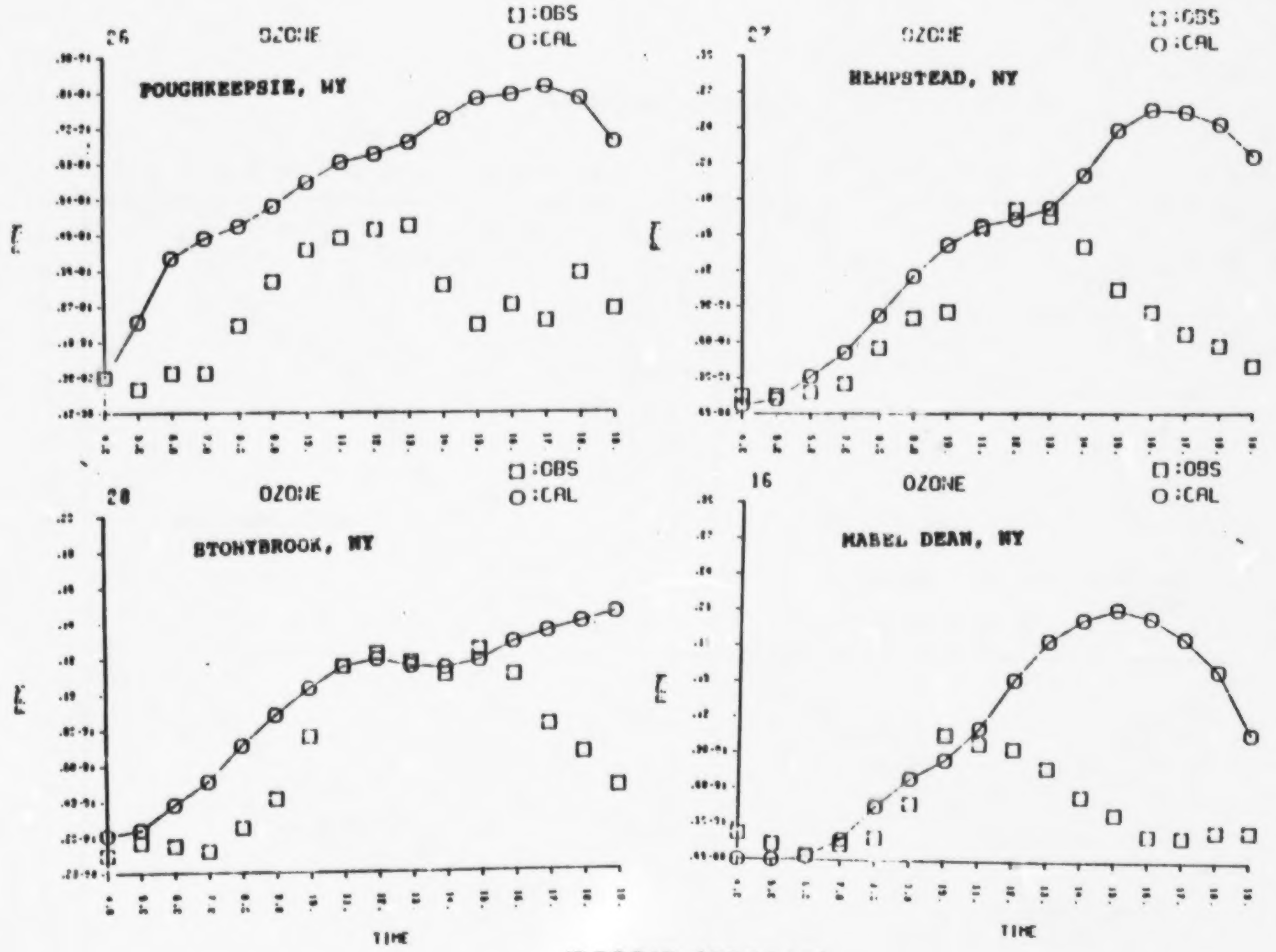

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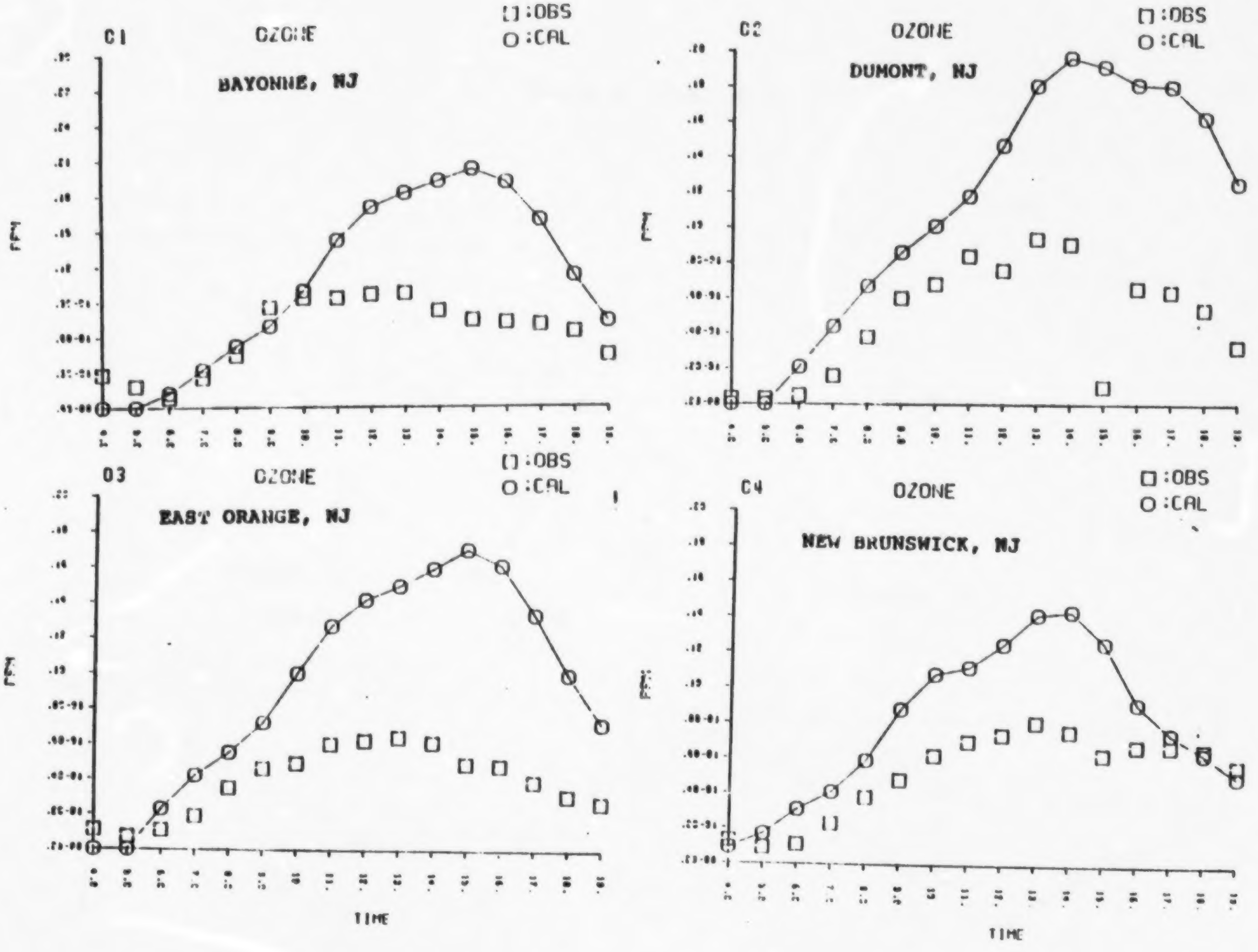

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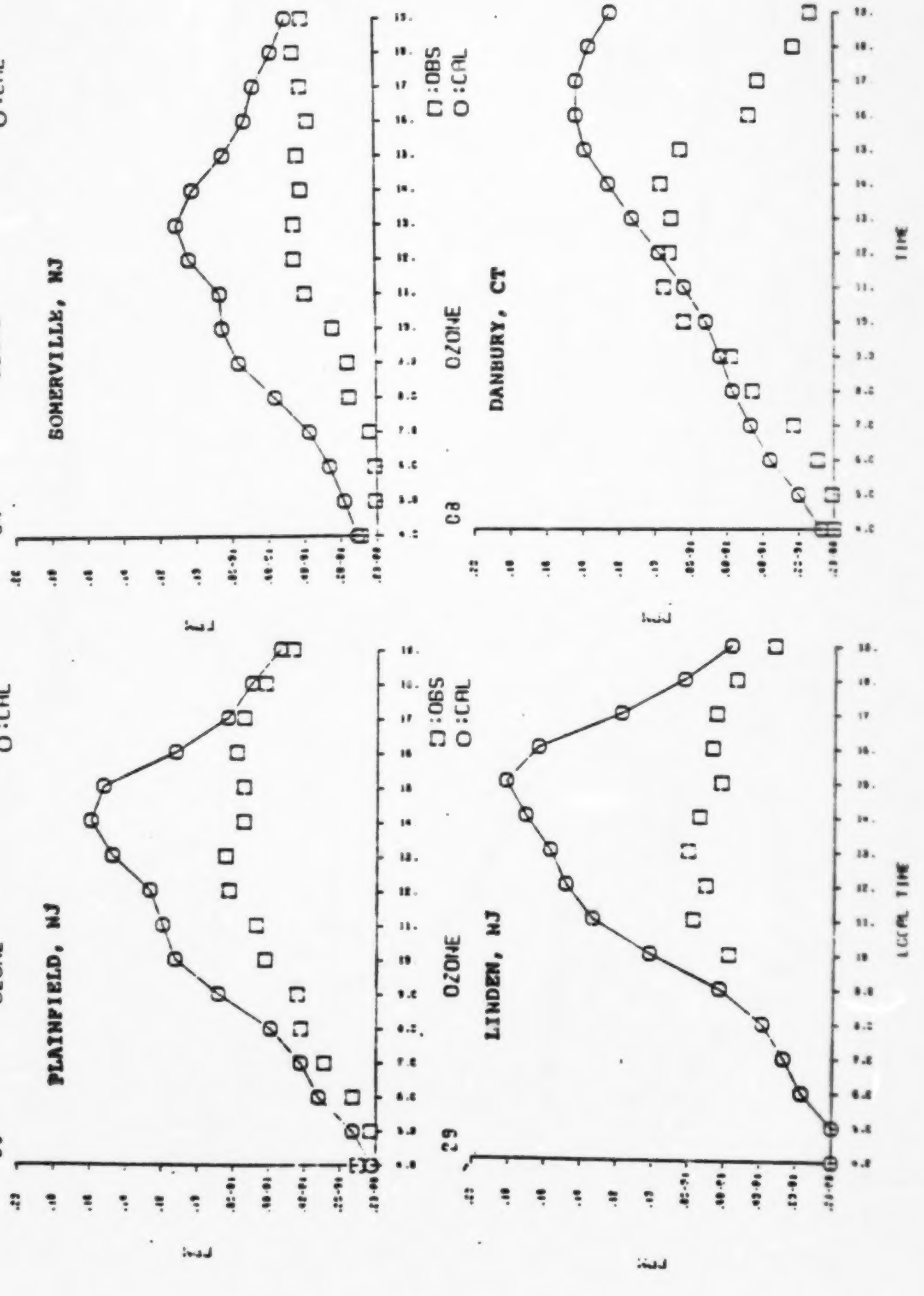
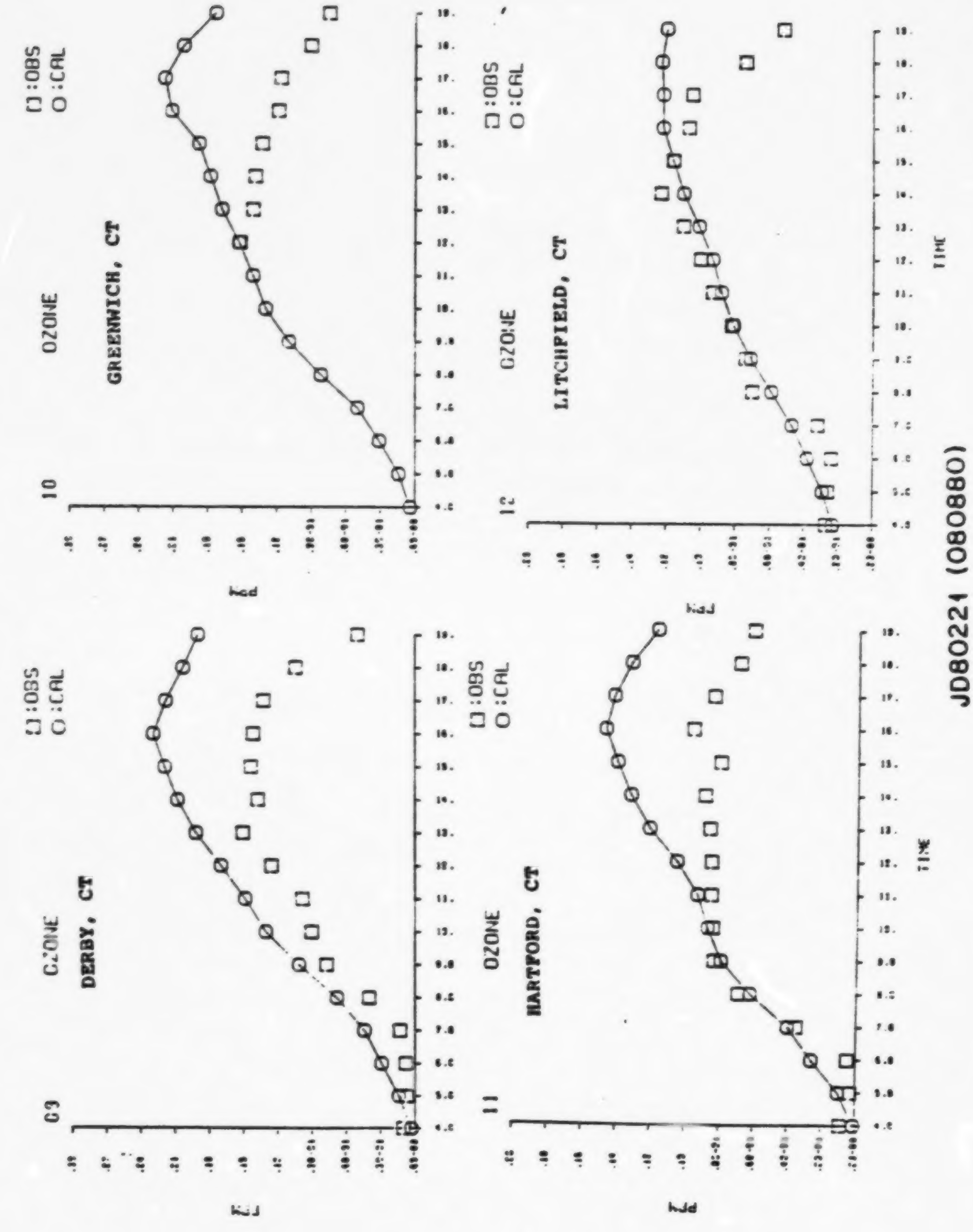


JD80219 (080680)

3-6 Diurnal Plots of the observed and predicted ozone concentrations at monitoring stations on JD80221(080880).



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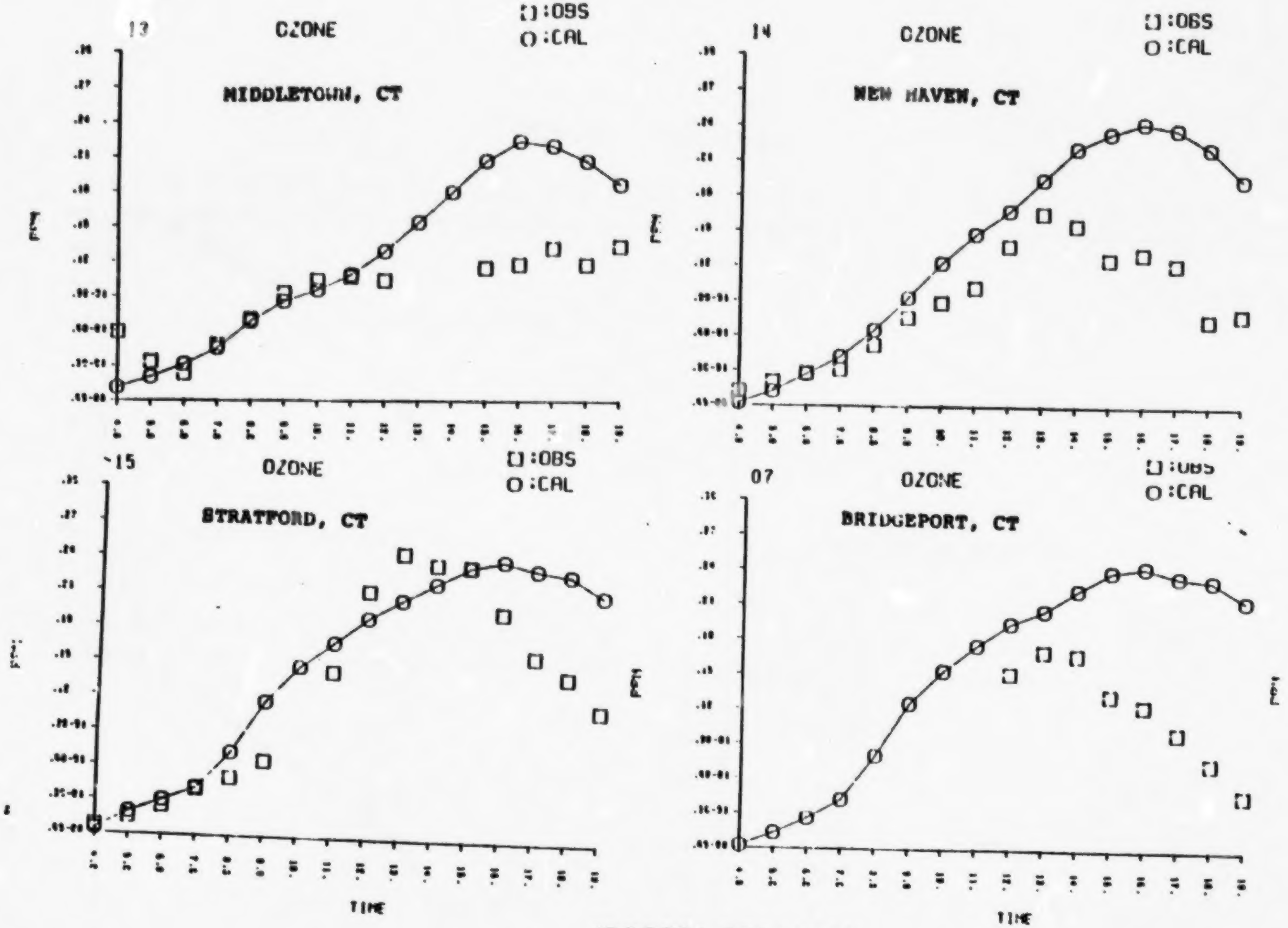

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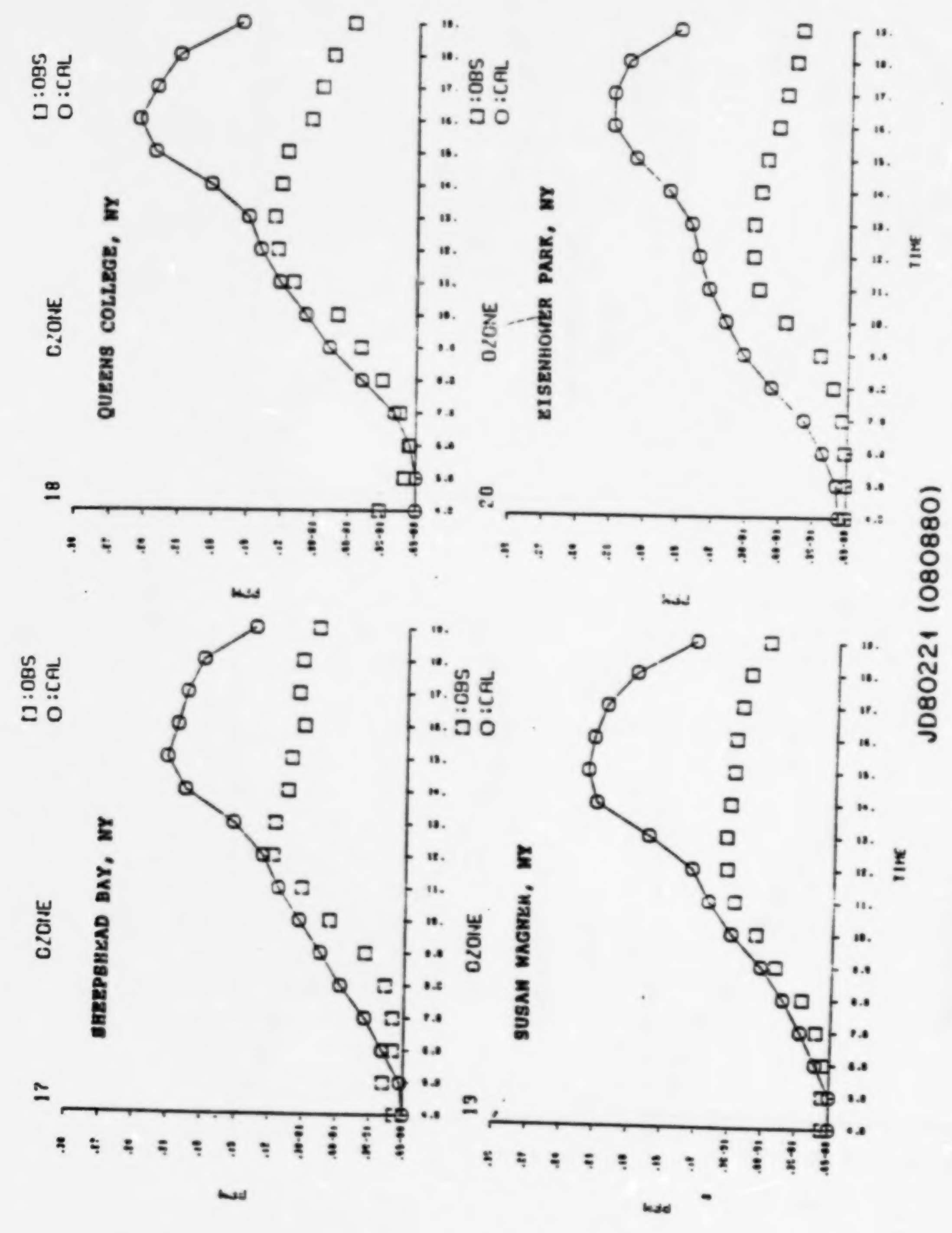

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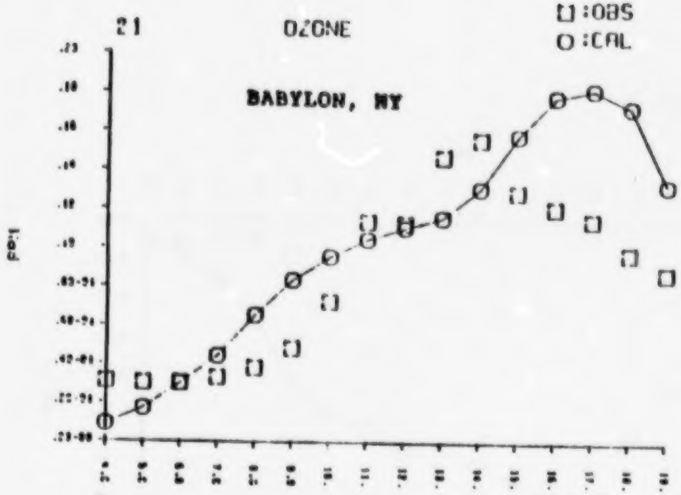

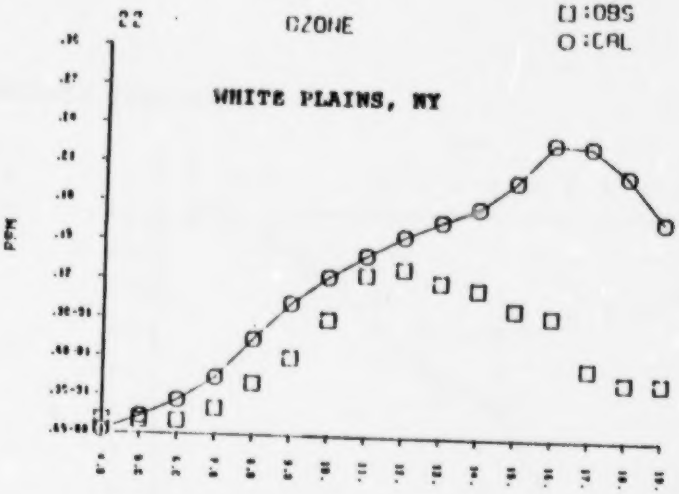

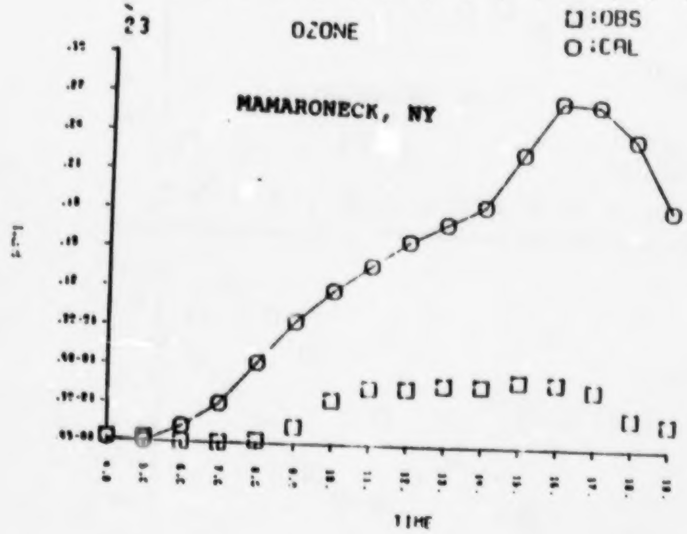

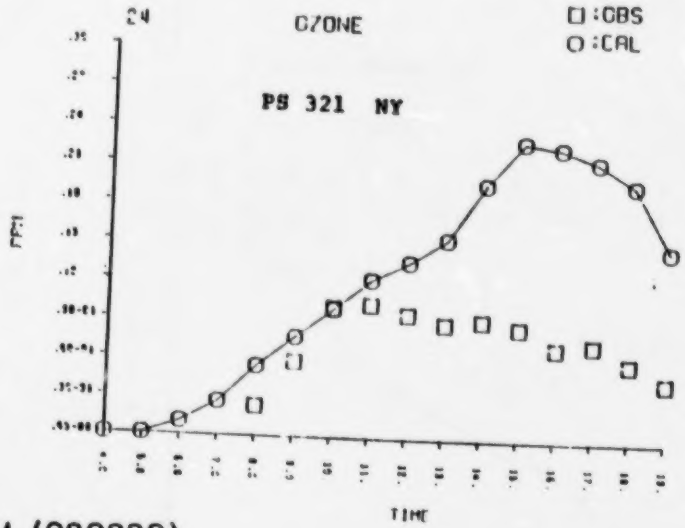

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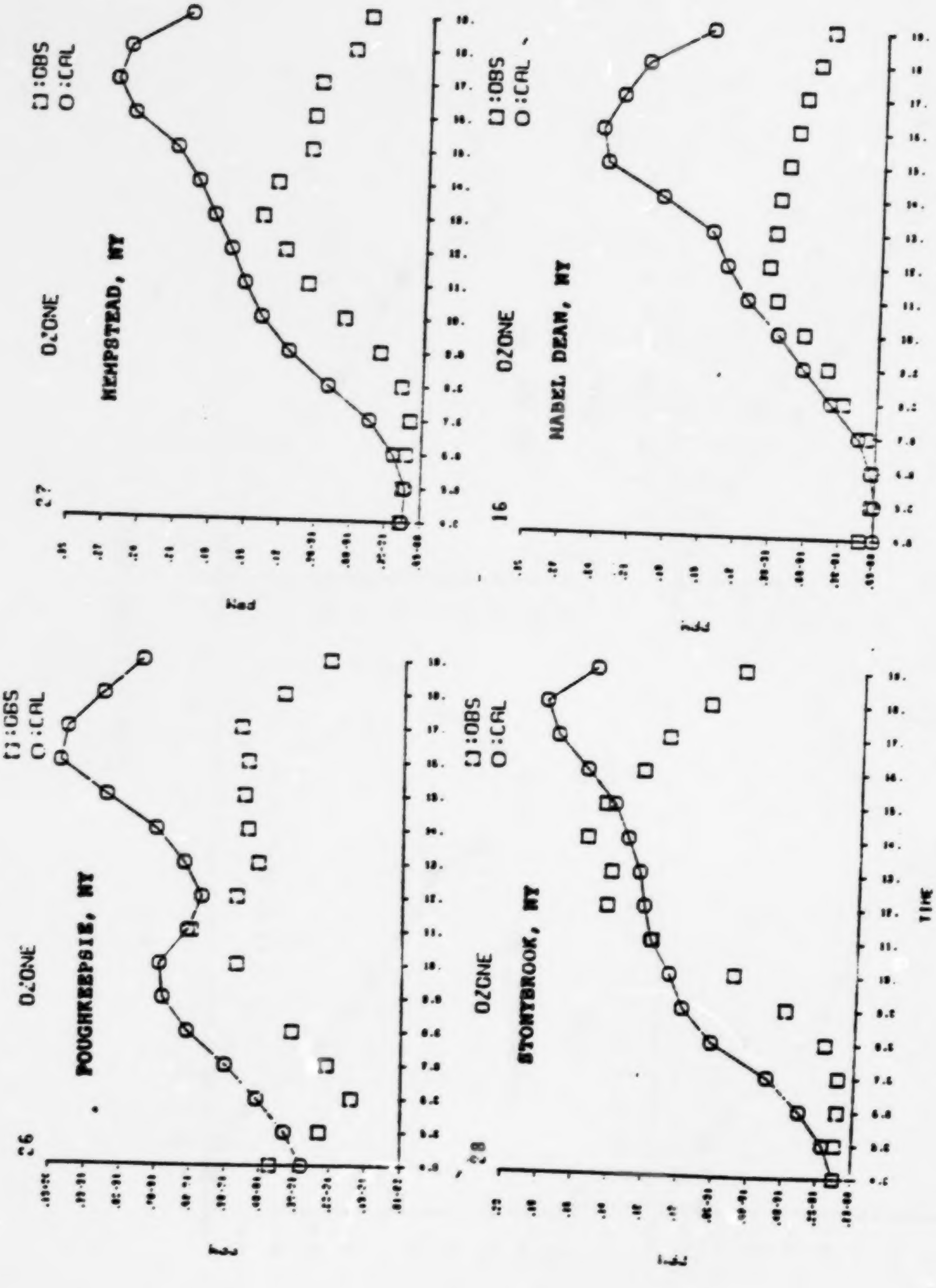

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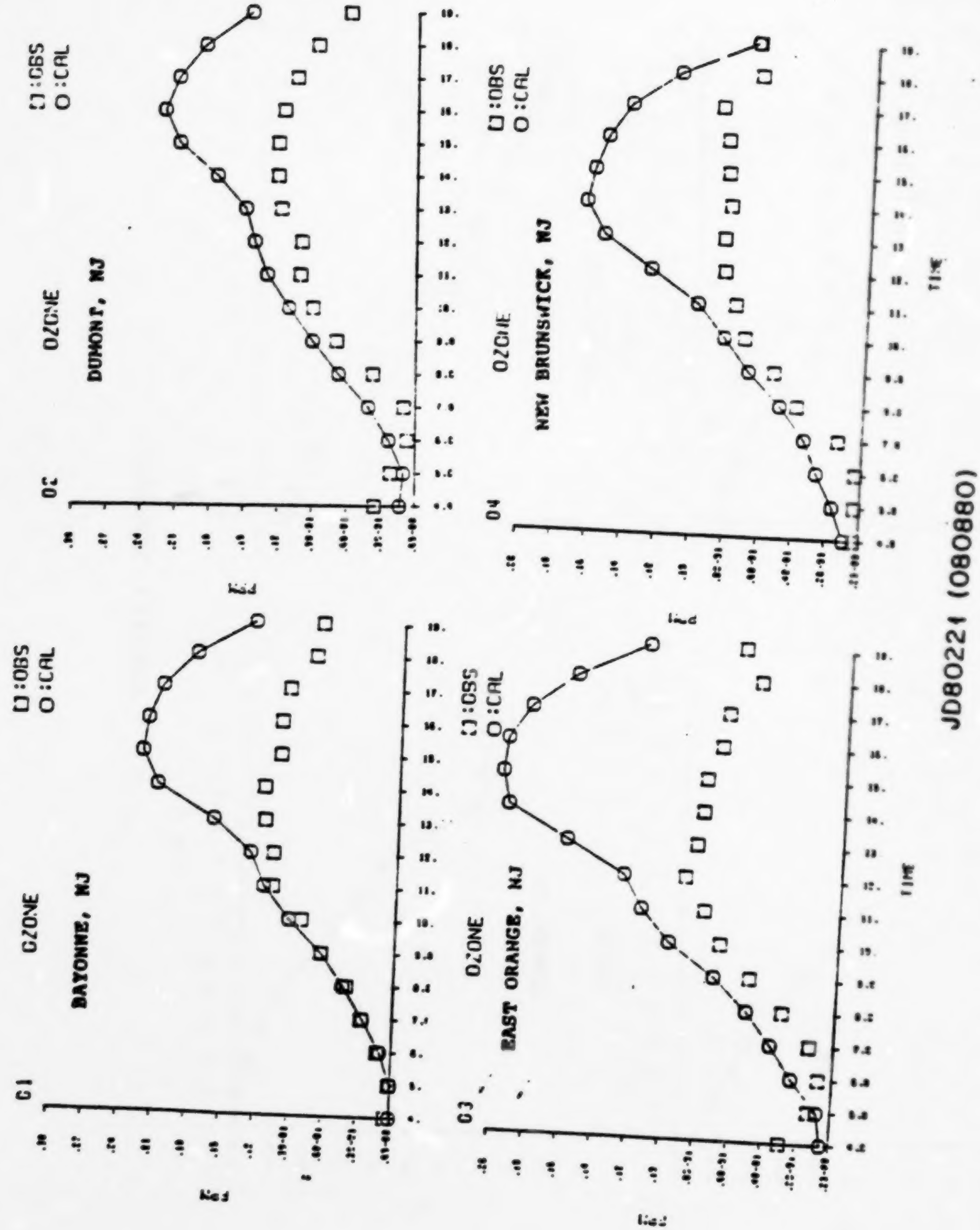

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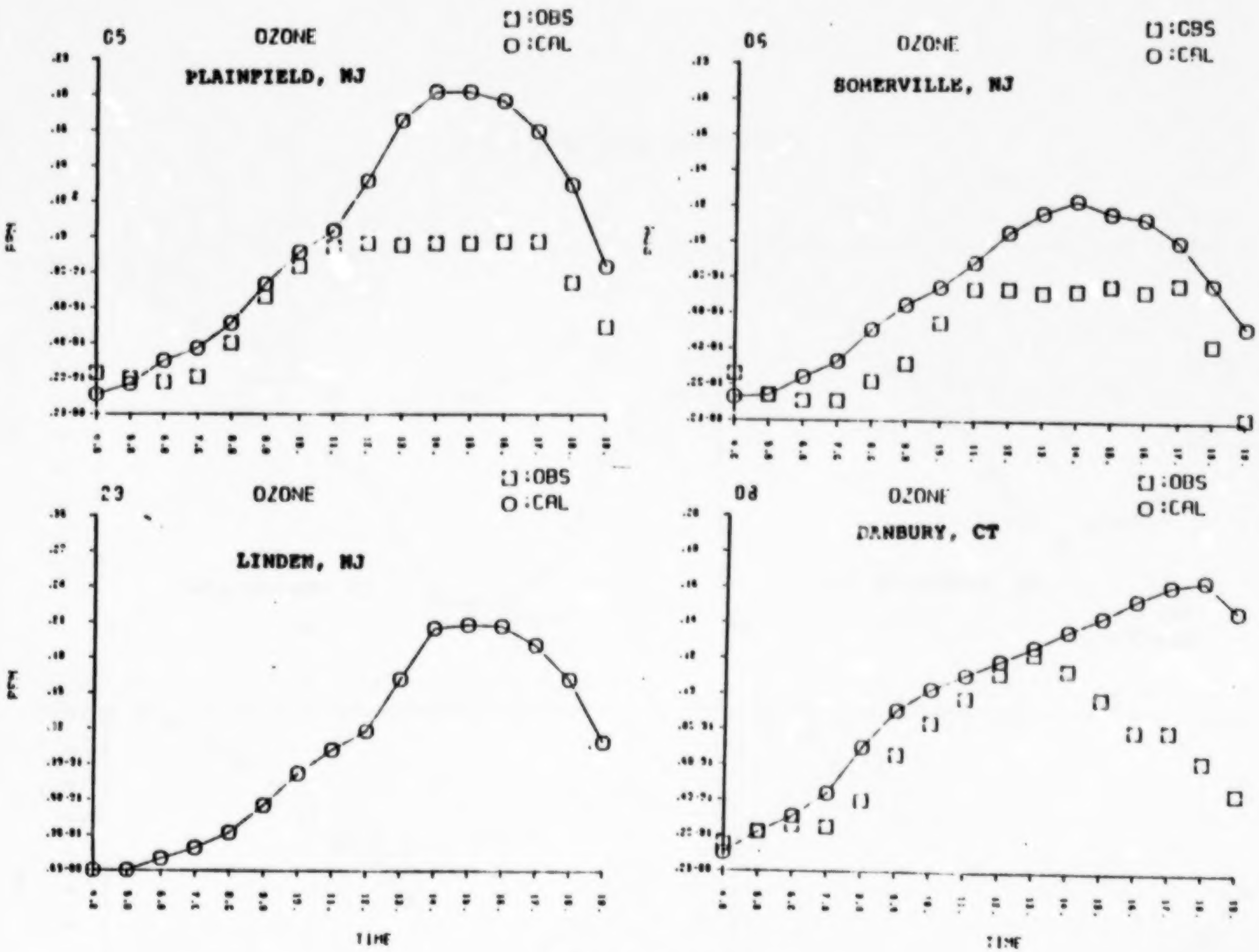

JD80221 (080880)

TECHNICAL REPORT DATA

(Please read Instructions on the reverse before completing)

1. REPORT NO.
EPA 450/4-87-011

2.

3. RECIPIENT'S ACCESSION NO.

4. TITLE AND SUBTITLE
Application of the Urban Airshed Model to the New York Metropolitan Area

5. REPORT DATE
May 1987

6. PERFORMING ORGANIZATION CODE

7. AUTHOR(S)
Dr. S. T. Rao

8. PERFORMING ORGANIZATION REPORT NO.

9. PERFORMING ORGANIZATION NAME AND ADDRESS
Division of Air Resources
New York State Department of Environmental Conservation
50 Wolf Road, Albany, New York 12233

10. PROGRAM ELEMENT NO.
J13A2A

11. CONTRACT/GRANT NO.
CX811945-01-0

12. SPONSORING AGENCY NAME AND ADDRESS
U. S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

13. TYPE OF REPORT AND PERIOD COVERED
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15. SUPPLEMENTARY NOTES

16. ABSTRACT

The goals of the "Oxidant Modeling for the New York Metropolitan Area Project (OMNYMAP)" are to examine (a) the extent and magnitude of the ozone problem in the New York area; (b) the impact of specific control strategies committed to by New Jersey, New York and Connecticut in the 1982 State Implementation Plans (SIPs); (c) the role of pollutant transport from upwind regions; and (d) strategies to meet and maintain ozone NAAQS in the New York area. In this study, the urban AIRSHED model was used to simulate five high ozone days in the 1980 oxidant season. The model results were analyzed to assess the performance of the model in simulating the observed ozone concentrations. Examining the data set of ozone concentrations greater than 100 ppb reveals that 60% of the predicted values were within ±30% of their corresponding observed concentrations. However, the model has a tendency to underpredict the peak concentrations over the modeling domain. The results of simulating the emissions controls to be implemented by 1988 indicate that although there is a decrease in the peak ozone levels, predicted concentrations are well above the NAAQS for ozone. Even with the imposition of extraordinary emissions control measures, the results of a one day simulation reveal that the peak ozone level continues to be well above the NAAQS. Analysis of the sensitivity of the ozone predictions to specific model inputs indicates that pollutant transport is important and that additional modeling is necessary to quantify the level of controls required to meet the ozone NAAQS in this area.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
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